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HIGHLIGHTS THIS MONTH

Full contents overleaf



REVIEW OF THE MONTH

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Lenovo ThinkVision 27 3D

We aren't suggesting that 3D monitors will ever be the dominant force on our desks, but we do think we should mark the arrival of Lenovo's ThinkVision 27 3D with a bang. Anyone who works in 3D dimensions, from architects to CAD designers to game makers, will appreciate being able to see their creations as they were intended to be seen – without the need to strap on a headset. You're also buying a high-quality 4K display, so when you're working in two dimensions your eyes still get a treat.



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PERSON OF THE MONTH p123 ADAM OSBORNE



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14,745,600



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An editor and his money are soon parted

I haven't gone through the pain of house-hunting for over a decade, but I still remember the X+1 problem. In my last search for a new home I had a hard price limit, determined by salary and savings, which meant there was zero point looking at properties above a certain budget. So why did I always find myself looking at houses just beyond?

The odd thing about those properties was that they were all perfect, while all the ones in my budget were never quite right. The kitchens were too small, the neighbourhoods were unsuitable, the gardens were odd shapes that the kids would hate. If only I could stretch that little bit further and buy the next house up in the listings, I lamented. My life would be complete!

As we're all aware, it's an illusion. If somehow the extra budget had fallen into my lap then I know full well that my eyes would have crept up to the next batch of houses that I couldn't quite afford. If only, I would have said, and the cycle would have repeated once more.

Today I'm not looking for a house, but I do need a new laptop. Again, I

have a budget, and I have my eye on a bunch of contenders. And this time, my X+1 problem relates to the graphics card. I'm not a gamer, but for once I'm trying to think ahead: I reckon that in two years' time generative AI services will have moved past their current alpha stage and will actually be usable, perhaps even woven into the operating system. And that means GPU power will become hugely important.

Yes, AMD and Intel are loudly arguing that CPU-based neural processing units will be crucial, but that ignores the incredible parallel processing power packed into the latest graphics chips. It's Nvidia that has grown rich on cloud-based AI, its stock price tripling in the space of a year as it's struggled to keep up with exploding demand for AI GPUs.

And it's Nvidia that's set to benefit from the rise of AI in PCs. Take a look at this month's bumper crop of laptops and you'll see that the Nvidia brand no longer just means gaming. Its mobile RTX chips are found in the Dell XPS 16 (see p50), HP Omen Transcend 14 (see p54), PCSpecialist 17in Recoil (see p56) and Asus Vivobook Pro 15 OLED (see

p60) systems. Only two of those would consider themselves gaming machines; discrete graphics chips are muscling their way into the mainstream.

Lenovo also mentions Nvidia in the manual for its ThinkVision 27 3D monitor (see p48), indicating an additional pathway for the company to make money. Buying a monitor? You'll want an Nvidia card with that.

My current laptop already has an Nvidia chip inside, but it's a modest GTX 1650 GPU. That's been fine for me; as I've said, I'm not a gamer. I am, however, someone who's interested in AI, and who has fallen just a little in love with Lenovo's 3D monitor. And so, once again I have an X+1 problem – or perhaps I should say an RTX+10 problem. For although an RTX 4050 would be okay, and an RTX 4060 better, shouldn't I really be looking for an RTX 4070 or 4080, just to be certain that it will last for a few years?

And having convinced myself of that, I suppose I might as well pay for an RTX 4090. You know, just to be sure.

Tim Danton
Editor-in-chief

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On p34, we reveal great habits for successful IT pros – but we also wanted to know about our contributors' bad habits that they'd like to change

"Less a habit and more a downside of the job, but because I'm always testing new kit I never settle on one thing – be it phone, monitor, webcam or whatever. It would be nice to have a stable computing system."

"My worst online habit is closing tabs and windows too soon, having been brought up on small screens and meagre memory. I'm forever reopening ones I need again, having closed them by reflex."

"I guess I have the bad habit of spending hours on end setting up networks and updating firmware and configuring test computers so that everything's perfect for the work I have to do... and then by the time I'm done there's no time left to do the actual work."

"I'm a terrible over-specper. I buy laptops more powerful than I need, broadband faster than I need, more mobile data than I need. It's bloody lovely, if financially ruinous."

"I wish I could remain undistracted. The problem is that the thing I use to do all of my work is also the fun internet machine, which means that whenever I write a full paragraph, I tend to then reward myself with an hour of Twitter before getting back to work."

"My first bad habit is too many machines (Ubuntu/Windows/Raspberry Pi) plugged into the same monitor. I'm forever switching inputs. I really ought to set them up as VMs. Second bad habit: getting crumbs in my keyboard."

"Telling people what I really think."

"The inability to refuse jobs which I know will be unsuccessful. I'll then spend hours (and often days) on the fool's errand, lying to myself that this time I'll learn something from the process before reality overwhelms the talent deficit and I collapse into a mire of self-loathing, furious that I've been unable to produce a miracle. This chain of events concludes with me not charging the customer for the non-repair."

"I keep data too long and in too many versions. A recent cull took some 50TB out of the primary stores."

"I'm told that my lack of any filter is a bad habit, but I'm rather fond of it so *#%^ off if you don't like it. See? As for tech bad habits, being an early adopter for stuff I really don't need."

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Briefing

Background and analysis on all the important news stories

Brits spin up 4K stream of Earth

UK firm starts streaming Ultra HD footage from space

It's strange, but despite so many TV channels and streaming options, it can still sometimes feel like there's nothing worth watching on the box. But by the time you're reading this, that could well have changed, as the majesty of the blue marble on which we live could soon be just a tap away, thanks to a near-permanent Ultra-High Definition, 4K live stream of the Earth from the International Space Station (ISS).

It's all thanks to British company Sen (sen.com), which recently launched its camera system on a resupply mission – and this month is due to put the cameras into place with the help of the station's robotic arm.

"We're going to be able to live stream continuously, subject to the occasional loss of signal," said Charles Black, the company's founder. "What we will be going live with at some point around late May is this 24/7 live stream."

The new system will have three sets of cameras: one pointing straight down, another at the horizon, and a third pointing at one of the ISS's docking ports, so that NASA can keep an eye on visitors to the station.

To make it work, the system will rely on an inter-satellite relay system that will use geostationary satellites, which permanently orbit above the same spot on Earth, to receive the data and then beam it back to the ground.

The actual camera hardware isn't a million miles away from the sort of cameras that might be found in the automotive industry. "Basically, we've used some commercial off-the-shelf components like camera sensors and processors, but we've designed many electronic systems where it all fits together," explained Black.

This isn't the company's first space-based camera. Founded in 2016, Black started out by working with the Russian rocket company

ABOVE The ISS is now home to a UK-produced 4K camera system

that built Yuri Gagarin's first spacecraft on a camera system for a Russian satellite, and it also launched its own small camera satellite as a test that is still active in space today. It meant that when the United States experienced a solar eclipse in April, Sen could share incredible footage of the shadow passing across the face of the Earth.

■ Ultra HD space

Given that most other live footage we see from space is so low resolution – mostly 720p – how is Sen streaming live in 4K? "We compress in real-time using H.265 on board the spacecraft or on board the camera system, so that then you don't need a huge

“We compress in real-time... so you don't need a huge amount of bandwidth to downlink it”

amount of bandwidth to downlink it," said Black.

"That's a big change from traditional satellites where

they'll take imagery, download the raw data and then do all of the post-processing back on the ground."

This did add further complication to the design of the system, though. "You need to think about how the electronics are going to be manufactured, how the pixels are going to be captured from the sensor onto the electronics, how they're then going to be processed and then delivered over the radio back to the ground," said Black

Similarly, getting the system on board the ISS posed its own challenges – and was arguably even trickier than launching an independent satellite. Though the ISS takes care of steering and propulsion, NASA's safety regime is unsurprisingly extremely strict, with the agency reviewing and testing every component – even ensuring that there aren't any sharp edges and that the glass lenses won't smash while on board.

"We had over 300 [electromagnetism] tests to prove that... our system was not going to interfere in any of the space station systems because there [are] humans on board," said Black. "It's been quite hard from a testing and planning point of view."

However, Black is hoping that the hard work will pay off, as he believes there's a lucrative "freemium" business case. "There's a lot of information you can extract like speed and direction," he said. "And because you're capturing movement over time, taking 30 frames a second, that enables us to use AI and other analytics to derive deeper insights that can be useful for a massive wealth of use cases, from shipping companies to environmental agencies monitoring the hundreds of environmental events that impact the planet every year."

He added: "Our data is going to be useful for financial institutions, traders, shipping companies, as well as environmental agencies."

And that's why the business model is going to be selling these deeper insights to big business, while letting the rest of us watch the live stream of the Earth for free.

"The vision is a 24/7 360° view of Earth from full disc, then with the satellites in Low Earth Orbit and with hosted cameras, we can then zoom down to see the detail of what's happening," said Black. "We want to give everyone the same view the astronauts have."

“The vision is a 24/7 360° view of Earth. We want to give everyone the same view the astronauts have”

Affinity takeover leaves customers wary

Canva moves in for British software firm that took on Adobe

You don't need to be a heavy Twitter user to know that feeling of gnawing anxiety when a software or service you use every day is taken over by another company. In an instant, the future of the tool that you rely on to get work done is thrown into doubt – and though it could mean great things that make the product better... it might not.

The latest community to experience this are customers of Affinity, the British-made suite of design tools that have taken on the almighty Adobe. Affinity Photo, Designer and Publisher are strong alternatives to Photoshop, Illustrator and InDesign, and they don't demand a monthly subscription but a modest one-off fee for the applications.

Now Canva, the web-based design platform, has acquired Affinity for an undisclosed sum. And that's left some customers fearing the worst, because Canva makes its money from selling subscriptions.

"I use Affinity on my personal computer in lieu of Adobe software specifically because of the lack of subscription," designer Ryan Finegan told *PC Pro*. "I don't believe that Affinity will always have a perpetual licence no matter what they say, so I am already expecting to have to migrate to [Adobe] Creative Cloud. The perpetual licence is the trade-off for using software that is feature lacking."

And the sentiment was similar on Reddit. "Everything just keeps

getting worse," one user quipped on seeing the news.

Affinity and Canva have done their best to try to settle nerves about the takeover and its potential implications. Perhaps anticipating a user backlash, the day after the acquisition announcement Canva unveiled four "pledges" to the Affinity community: that it will "accelerate" the rollout of new features, that apps will be made available to schools and registered non-profit organisations, and that the future of the products would be "community led".

And then there was the pledge that hardcore Affinity users were perhaps looking for the most: that "perpetual licences will always be offered" and that "we will always price Affinity fairly and affordably".

The message was reinforced by Affinity CEO Ashley Hewson in a video message to customers. "Nothing changes," he said. "All of our team is still here, there's no lay-offs or changes in that regard whatsoever, and we're more focused than ever I think to deliver some incredible updates."

"Our apps are still available on our website. The V2 apps are still available as a one-off purchase, and everyone who's bought our apps previously, of course, can still use them in perpetuity moving forward."

Of course, only time will tell whether Canva sticks to its pledge, but if it doesn't, perhaps Affinity users could stage a protest. And we know a great piece of software on which they could design their banners...

BELOW UK-based Affinity provides subscription-free alternatives to Adobe Photoshop, Illustrator and InDesign



Dial M1 for murder

There's an unpatchable flaw in Apple silicon. **James O'Malley** investigates whether Mac owners should be concerned

We're now over three years into one of Apple's biggest ever gambles. At the tail end of 2020, the company made a major architectural change, moving from building computers that use Intel-built x86 chips to ARM-based chips of its own design.

As soon as the first M1 Macs launched, the reason for the change became clear. The new system on a chip (SOC) was dramatically faster, ran cooler and consumed less energy than anything Intel could offer – and sales quickly soared.

However, this wild success has just become a little bit awkward. A new hardware vulnerability has emerged, named GoFetch, which can conceivably compromise the millions of devices around the world that use these chips. And, even worse, the problem is thought to be unpatchable.

■ Side-channel attacks

How big a deal is this vulnerability in Apple's processors? "There is always a trade-off between security and performance," said Jeremy O'Donoghue, chair of the TEE-MCM Attack Experts Working Group at GlobalPlatform, an international standards organisation that promotes secure chip technology.

He explains how GoFetch is a "side-channel" attack that takes advantage of a particular feature of Apple's SOC. "Everybody thinks that a microprocessor basically fetches an instruction, acts upon it, and then goes and fetches the next one," he said. "That really hasn't been true since about 1995, and it's really, really not true now."

Instead of reading and writing values to a machine's

“Imagine a thief trying to figure out what's inside a house not by breaking in, but by observing shadows through the curtains”

dedicated RAM, the Apple silicon uses an internal cache to speed up processing. "What the cache is doing is making a prediction about what you're probably going to want to pull out of memory next," he said, describing how the attack works by using a form of deductive reasoning.

"You can have what we call

an attacker process, which looks at features like the cache and puts it into a known state. It waits for the victim process to do something, and then goes back and has another look at the state," said O'Donoghue. "It can infer information about what the victim process did by the behaviour of the cache or the other microarchitectural features."

The cache is a shared resource between the different

processes that run the CPU. Once the "victim" process accesses memory, the attacker can figure out different things about what the victim is doing.

"Imagine a thief trying to figure out what's inside a locked house not by breaking in, but by observing shadows through the curtains or listening to sounds inside," said Michael Skelton, vice-president of security operations at Bugcrowd, a cybersecurity platform.

"Side-channel attacks exploit indirect clues about the data or operations happening in a computer system, such as the amount of time tasks take or the power usage patterns, to gain unauthorised access to sensitive information."

Though this quickly gets bogged down in some rather complicated computer science, the upshot is

Echoes of Spectre and Meltdown

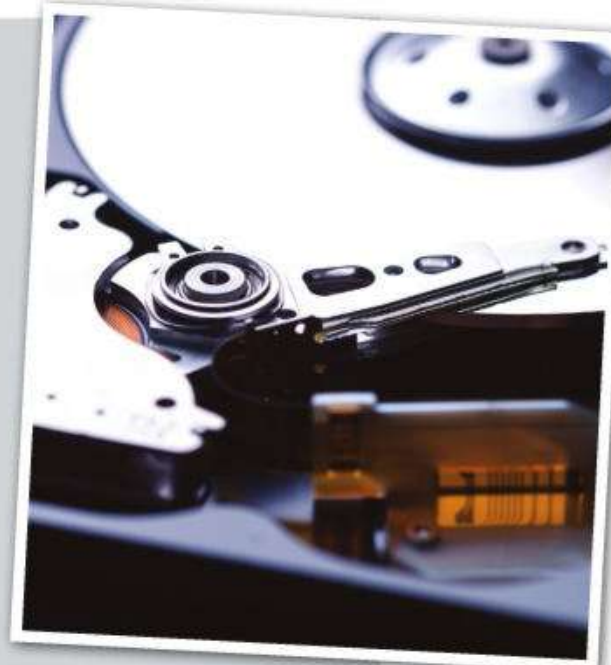
Side-channel attacks such as GoFetch are not that common in the real world for the reasons stated previously – there's usually an easier way. "A side-channel attack basically is something that uses a side effect of legitimate functionality to expose small bits of information that can then be pieced together," said Malwarebytes' Reed.

Consequently, most vulnerabilities tend to be uncovered in the lab, rather than actively used by nefarious actors. Over the years researchers have come up with novel and amusing ways that a side-channel attack could conceivably leak data out. For example, it's possible that malware could use the pattern of blinks of an LED or the sounds created by the hard disk being scratched to exfiltrate data. But unsurprisingly, these would be very difficult to pull off in the real world.

Nevertheless, the risks from side-channel attacks are still taken extremely seriously by cybersecurity professionals – and as with GoFetch, occasionally there are vulnerabilities

uncovered that do spark serious concerns. For example, in 2018 two vulnerabilities emerged called Spectre and Meltdown. Both worked in slightly different ways, but it was discovered that the problem could conceivably affect processors made by all of the largest players: Intel, AMD and ARM.

As a result, patches were quickly issued to all of the major operating systems – even though, especially in the case of Meltdown, there were performance trade-offs to be made.

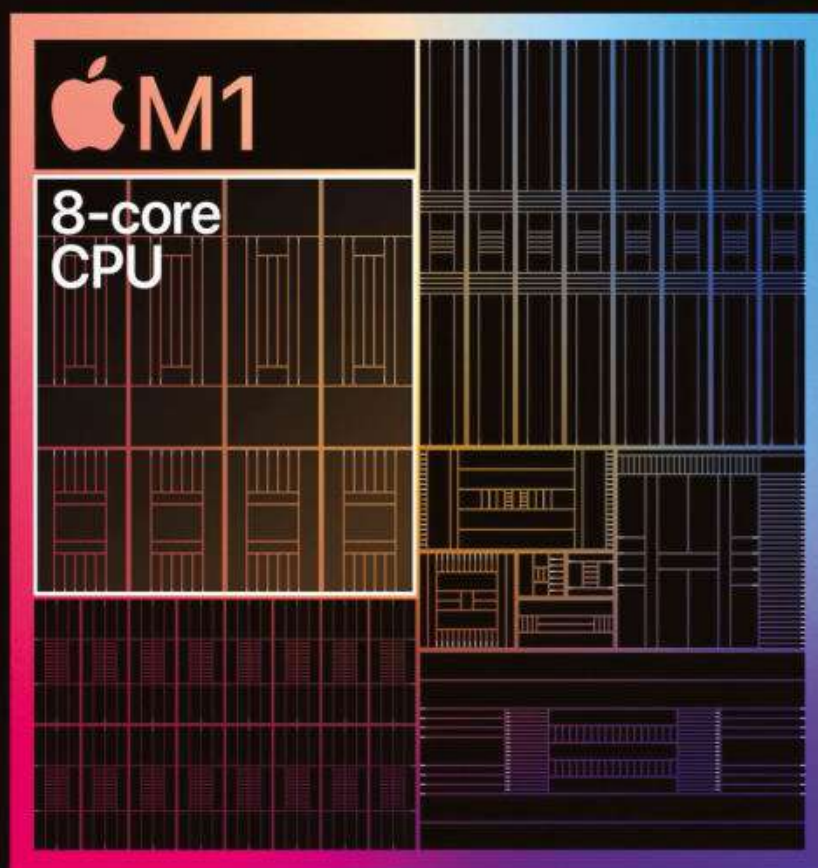


Side-channel attacks come in many forms, including listening to hard disks

8-core CPU

The highest-performance CPU we've ever built.

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performance¹



hit. But that's never what you do," said O'Donoghue.

Instead, Apple and developers would focus on the particularly acute vulnerabilities, such as with TLS, where a patch could be plausible. "A modern CPU can quite comfortably deal with really quite fast encrypted network interfaces," said O'Donoghue. "Anyone who's not basically just plugged their laptop into a fibre optic isn't really going to notice very much. It will slow things down a tiny bit, but not very much."

■ Panic over?

Ultimately, then, there's a

startlingly simple: by using this process, an attacker could conceivably gain access to the cryptographic keys used to encrypt data on Apple's computers.

According to O'Donoghue, Macs typically use hardware-based encryption for storage – meaning accessing files stored on the disk may still be off limits. But there are other parts of the system, such as network capabilities, that could conceivably be compromised. "The most likely attack would be on something like a VPN or on a TLS connection, so a secure HTTP, for example," he said.

■ Can it be fixed?

Given the risks from the exploit, the obvious question is: what can be done to fix it? Here the picture is mixed.

"There's nothing that you can really do to fix that because it's in the hardware," said Thomas Reed, director of cyber technology at Malwarebytes. "But there are some software-based things that people could do, that developers could do to mitigate it."

At a minimum, we can perhaps expect a patch at some point in the not too distant future. However, if Apple or third-party developers do release patches, this isn't like fixing a bug in a line of code. Instead, they will have to grapple with a core trade-off. "Cryptographic operations will run a little slower, but they'll be more secure because that prefetcher is what's causing the problem," said Reed.

O'Donoghue thinks that it can be done without a significant drag on performance. He describes how Apple's M-series chips are divided into different performance and efficiency cores, so code can be rewritten to take advantage of these separate processes.

"If you have cryptographic code, you can just make sure that you only run that on efficiency cores," he said. "It's a bit of a pain in the neck to do. You are going to have to patch your crypto code, but you can do that."

He isn't too worried about the performance hit this would cause. In fact, he'd be surprised if anyone notices at all. "If you wanted to stop this from ever happening in all possible circumstances without changing the software, there would be some significant performance

ABOVE The recently discovered flaw in Apple silicon could be hard to fix

potential vulnerability out there that has been spotted by security researchers, and no way to fix the hardware. Does that mean that Mac owners reading this should worry about their machine being compromised?

"There's still concerns, but they're more lab-setting concerns than [comparable] to something like Log4j, where it was very tangible, very mass exploitable, and everybody was impacted," said Skelton, referring to the major vulnerability that emerged in 2021 in a piece of open-source logging software that was used by countless major organisations.

The good news is that as far as GoFetch is concerned, even though it is theoretically a vulnerability, the experts don't expect it to be widely used by hackers. "If you're already at the point where you can gain that level of

access, you've got that level of ability, you probably don't need a vulnerability like this," said Skelton.

"If I wanted to hack someone, I don't need to go to this level of detail, I can usually go and get a breach database, find a password they've used before and start logging into their accounts."

Skelton thinks that Apple will be quick to address the problem anyway. "Of the vendors, I would say Apple is the most proactive at addressing security risks, even when they are more benign and impact a specific threat model," he said.

That's why Malwarebytes' Thomas Reed isn't going to start panicking yet, either – though he does argue that if you're a particularly high-value target, it might be worth looking at alternatives.

"I've got two M1 machines here, I'm not replacing either one of them," he said. "I'm going to keep using them confidently."

"However, if you're somebody like an investor in cryptocurrency, you've got a wallet on your machine that's got a very large amount of money in it... that's all protected by one little key, and you could be a big target."

“Ultimately, there's a potential vulnerability out there that's been spotted by security researchers, and no way to fix the hardware”

The A-List



The best products on the market, as picked by our editors

PREMIUM LAPTOPS

Apple MacBook Pro 16in (2023)

M3 power from £1,699
from apple.com/uk

The M3 chips give the already brilliant MacBook Pro series a boost in games with no sacrifices elsewhere, so power users who are happy with Apple must grapple with the big decisions: which M3 chip, which size of screen, and how much RAM and storage?

REVIEW Issue 352, p46



BUSINESS LAPTOPS

Lenovo ThinkPad X1 Carbon Gen 11

Business class from £1,583 exc VAT
from lenovo.com

Fight past Lenovo's opaque pricing – another flash sale, really? – and you'll find a slim, powerful and long-lasting laptop for a competitive price. With a wide range of available configurations, all based on Intel's 13th generation Core chips, this is our top choice for all sizes of business.

REVIEW Issue 350, p85



ALTERNATIVES

NEW ENTRY

HP Spectre x360 14 (2024)

An Intel Core Ultra 7 processor means that this is a fast 2-in-1 as well as being beautifully designed, with a sumptuous screen and excellent battery life.
£1,899 from hp.com/uk
REVIEW Issue 355, p62

Apple Mac Book Air 13in (M3)

Both the 13in and 15in MacBook Airs impress for speed, styling and battery life, but the 1.2kg 13in Air wins out of the two for its sheer portability. **From £1,299 from apple.com/uk**
REVIEW Issue 356, p54

Asus Vivobook Pro 15 OLED (2024)

A mobile workstation disguised as a slim laptop, the Core i9/RTX 4060 combo provides a staggering amount of power in its high-quality, 1.8kg frame. **£1,600 from uk.store.asus.com**
REVIEW Issue 357, p60

Dell Latitude 7340

This 1.1kg laptop offers terrific battery life and, if you choose the better non-touchscreen (look for 400 nits of brightness in the specs) it's a joy to use, too. **From £1,109 exc VAT from dell.co.uk**
REVIEW Issue 350, p82

Acer TravelMate P6 (TMP614-53)

The all-new TravelMate P6 benefits from a 14in OLED screen with a 2,880 x 1,800 resolution, plus a very generous spec for the price. It's simply great value. **£1,209 exc VAT from acer.co.uk**
REVIEW Issue 350, p80

HP Dragonfly G4

It's not the fastest machine you can buy, but otherwise this 1kg masterpiece is as close as you're going to get to the perfect business laptop for executives. **From £1,380 exc VAT from hp.com**
REVIEW Issue 352, p58

GAMING LAPTOPS

Asus ROG Zephyrus G14 (2024)

Ultraportable gaming from £2,400
from rog.asus.com

Asus' ROG Zephyrus range of gaming laptops has always placed an emphasis on portability, but this sleek 1.5kg laptop takes that to a new level. It maxes out at an RTX 4070, but that's enough to deliver triple-figure frame rates in AAA games – and the 120Hz 14in OLED screen just adds to the speed.

REVIEW Issue 356, p60



EVERYDAY LAPTOPS

Honor MagicBook 16 X (2023)

Full metal jacket for £700
from honor.com

A high-quality all-metal chassis marks the MagicBook 16 X 2023 out from the budget laptop crowd, and it's packed with good-quality (albeit not top-quality) components, from a 12th gen Core i5 chip to a 1,920 x 1,200 16in IPS panel.

REVIEW Issue 348, p59



ALTERNATIVES

NEW ENTRY

Lenovo Legion 9i Gen 8 (16in Intel)

The liquid-cooling system may be only for bragging rights, but this slim laptop delivers the goods with a superb 16in mini-LED screen. **RTX 4090, £4,180 inc VAT from lenovo.com**
REVIEW Issue 353, p58

HP Omen Transcend 14

This compact, stylish 14in OLED gaming laptop packs a punch thanks to its RTX 4060 graphics. **Part code, 9R292EA#ABU. £1,799 from hp.com/uk**
REVIEW Issue 357, p54

Razer Blade 18 (2023)

A great advert for 18in gaming laptops, the Blade 18 partners a Core i9-13950HX with RTX 40-series graphics. **From £2,900 from razer.com/gb-en**
REVIEW Issue 343, p52

NEW ENTRY

Asus Vivobook S16 OLED (2024)

A great-value laptop with a 16in 120Hz OLED panel and Core Ultra 7, and it's sleek and stylish, too. **Part code, S5606MA-MX008W. £1,200 from scan.co.uk**
REVIEW Issue 357, p61

Microsoft Surface Laptop Go2

The Laptop Go 2 won our recent group test of affordable laptops thanks to its high-quality 12.5in screen, 1.1kg weight and sleek design. **£555 from microsoft.co.uk**
REVIEW Issue 347, p89

MSI Prestige 15

Not the most cultured laptop, but great value considering the connectivity, 15in screen, fast specs and a GeForce RTX 3050 GPU (part code A12UC-034UK). **£849 from laptopoutlet.co.uk**
REVIEW Issue 347, p93

CHROMEBOOKS

Acer Chromebook Spin 714

Flipping great for £799

from [currys.co.uk](https://www.currys.co.uk)

Simply the best Chromebook around. Others may beat the 12th gen Intel Core i5 we tested for performance, but for features, design and bang for buck you won't find any laptop that can match this convertible for £799.

REVIEW Issue 356, p83



Acer Chromebook Plus 515

This Chromebook Plus laptop is all about value. With strong speeds thanks to Intel's Core i5-1235U processor, and a good-quality 15.6in panel with a 1,920 x 1,080 resolution, Asus' Chromebook Plus 515 is ideal for families, students and business users, providing mobility isn't your main priority as it isn't particularly light at 1.7kg. **£429 from [currys.co.uk](https://www.currys.co.uk)**

REVIEW Issue 356, p82

Lenovo IdeaPad 5i Gaming Chromebook Plus

The 120Hz 15.6in display is the star of this Chromebook, as it should be with 2,560 x 1,600 pixels to play with. You're getting a lot of laptop for the price, too, including a 512GB SSD, Core i5-1235U processor and 8GB of RAM. Just note the 1.9kg weight.

£659 from [very.co.uk](https://www.very.co.uk)

REVIEW Issue 356, p88

EVERYDAY PCs

Apple Mac mini (2023)

M2 masterpiece from £649

from [apple.com/uk](https://www.apple.com/uk)

The outside remains the same, but this simple yet effective update to the Mac mini introduces the M2 and M2 Pro processors with predictable effect. The entry-level price quickly rises once you start upgrading – moving from 8GB to 16GB costs £200, as does doubling the base storage from 256GB to 512GB – but there's enough power here to last you for years.

REVIEW Issue 343, p60



Intel NUC Pro 13

If you don't need discrete graphics then Intel's mini PCs are a fantastic choice, being easy to upgrade, low on energy consumption and more than powerful enough to cope with Windows applications – despite being little larger than a coffee coaster.

Barebones, from £350; full PCs, from £600, from [scan.co.uk](https://www.scan.co.uk)

REVIEW Issue 345, p48

PCSpecialist Fusion Elite P

A promising debut for AMD's Ryzen 8600G processor, this quiet-running, power-efficient system packs in lots of performance considering it costs so little. And a slot sits empty for a future graphics card upgrade should the built-in graphics prove insufficient for your gaming needs.

£649 from [pcspecialist.co.uk/reviews](https://www.pcspecialist.co.uk/reviews)

REVIEW Issue 355, p54

ENTHUSIAST PCs

Cyberpower Ultra R77 RTX Gaming PC

RTX Super 4080 power for £2,275

from [tinyurl.com/356cyber](https://www.tinyurl.com/356cyber)

The striking case catches the eye, but it's the potency of AMD's Ryzen 7 7800X3D and Nvidia's RTX 4080 Super graphics that leave the lasting effect.

REVIEW Issue 356, p62



HP Omen 45L (2023)

We tested the top-end 45L with a Core i9-13900K, GeForce RTX 4090 graphics and 64GB of RAM, and it doesn't come cheap. Switch to the Core i7/RTX 4070 Ti version, however, and the price almost halves without losing any of the superb design and build quality.

£4,800 from [hp.co.uk](https://www.hp.co.uk)

REVIEW Issue 347, p50

Alienware Aurora R16

An understated yet stylish gaming PC that runs quietly even when pushed. This rig has power where it counts, mixing Intel's latest CPUs with Nvidia's RTX GPUs. Choose an RTX 4070 or higher to benefit from the glass side and liquid cooling, which lifts it above rivals.

From £1,349 from [dell.co.uk](https://www.dell.co.uk)

REVIEW Issue 349, p54

ALL-IN-ONE PCs

HP Envy 34 All-in-One

£2,099 widescreen wonder

from [hp.com](https://www.hp.com)

Built around a high-quality 34in widescreen – which is perfect for viewing two windows side by side thanks to its 21:9 aspect ratio – this also comes with Nvidia RTX 3060 graphics. We're big fans of the magnetic 16-megapixel camera, too.

REVIEW Issue 335, p46



Dell Inspiron 24 All-in-One

Despite being built to hit a price point, the Inspiron 24 All-in-One manages to look classy, include a good-quality, 1,920 x 1,080 24in panel and have enough power to breeze through a typical day's tasks. It even packs mod cons such as a 720p webcam. Superb value for money.

From £599 from [dell.co.uk](https://www.dell.co.uk)

REVIEW Issue 350, p47

Apple iMac 24in (M3)

The iconic design remains the same, but the plain M3 chip inside the revamped iMac 24in is a revelation compared to the previous M1 version. The downside is that the base configuration includes a stingy 8GB of memory and a 256GB SSD.

From £1,399 from [apple.com/uk](https://www.apple.com/uk)

REVIEW Issue 352, p52

CREATIVE WORKSTATIONS

Scan 3XS GWP TR Ada

Record breaker for £14,167 exc VAT

from [scan.co.uk](https://www.scan.co.uk)

A 64-core Ryzen Threadripper 7980X blows everything that went before out of the water with multithreaded tasks, while Nvidia's RTX 6000 Ada graphics dominates for viewport acceleration and GPU rendering. Even storage throughput is unparalleled. With a striking chassis and brilliant build quality, you'll want for nothing.

REVIEW Issue 353, p52



Armari Magnetar MC16R7

A strikingly fast workstation for the money, with Armari's customised liquid cooling extracting the most from an AMD Ryzen 9 7950X. With 64GB of DDR5 RAM and AMD's Radeon Pro W7800 in support, this is a fantastic value machine.

£3,758 exc VAT from [armari.com](https://www.armari.com)

REVIEW Issue 348, p84

PCSpecialist Onyx Pro

Even in a creative workstation, it makes a lot of sense to include Nvidia's consumer graphics due to its core-per-buck. Here, an Nvidia RTX 4090 partners with a Core i9-13900K and an incredible 192GB of RAM to tremendous effect.

£3,750 exc VAT from [pcspecialist.co.uk/reviews](https://www.pcspecialist.co.uk/reviews)

REVIEW Issue 348, p86



TABLETS

Apple iPad Pro 12.9in

Simply the best, from £1,249

from apple.com/uk

The best tablet out there thanks to Apple's powerful M2 chip, even if the upgrade prices sting in their usual fashion. In return you'll get a workhorse during the day (especially with the optional Magic Keyboard) and a brilliant entertainer at night.

REVIEW Issue 352, p84



Samsung Galaxy Tab S9 Ultra

The best of the big-screen Android tablets, with the bonus of Samsung's DeX environment if you want to use it as a desktop replacement, while One UI lets you manage multiple windows and multitask between them. The 14.6in AMOLED screen is superb, too.

From £1,199 from samsung.com

REVIEW Issue 352, p87

OnePlus Pad

The OnePlus fully justified its place in our luxury tablet Labs thanks to its outstanding build quality, slick performance and stunning 17-hour battery life. It's the best Android option outside of Samsung's Galaxy Tabs – and it won't do nearly so much damage to your wallet.

£449 from oneplus.com

REVIEW Issue 352, p86

EVERYDAY PHONES

Motorola Moto G54 5G

Great looker for £180

from johnlewis.com

The 6.5in 120Hz IPS display is the G54's standout feature, but it improves on the previous generation in numerous ways while being even cheaper. It's faster, looks better, takes great photos and battery life is strong. You won't find better for less than £200.

REVIEW Issue 355, p77



Google Pixel 7a

A phone that begs the question: why spend £150 more for the Pixel 7? With few compromises on the Pixel 7 – it uses the same processor and cameras and the only notable change is a smaller screen – this is the new mainstream pick for Google phone fans.

128GB, £449 from store.google.com

REVIEW Issue 346, p68

Motorola Edge 30 Neo

This stylish and compact smartphone – reflected by a small-ish 4,200mAh battery – includes a gorgeous 6.3in OLED screen, nippy Snapdragon processor and a decent pair of cameras for a great price.

£300 from motorola.co.uk

REVIEW Issue 348, p73

PREMIUM PHONES

Samsung Galaxy S24 Ultra

AI cleverness from £1,249

from samsung.com/uk

The undeniably high price gets you a bunch of AI tools that will genuinely save you time (and money). While we miss the 10x optical zoom of the S23 Ultra, the 5x zoom camera and supporting cast capture brilliant images, while the S Pen is always on hand to scrawl notes and pictures.

REVIEW Issue 354, p58



Google Pixel 8

It's not a huge step up from the Pixel 7, but the added AI features are genuinely useful and it benefits from a handful of upgrades, too – including a 120Hz screen and the new Tensor G3 processor. If you don't mind the lack of optical zoom, it's a great buy for the price.

128GB, £699 from store.google.com

REVIEW Issue 351, p72

Samsung Galaxy Z Flip5

While the Galaxy Z Fold5 has its undoubted attractions, the Flip5 pips it onto this A List slot thanks to it being £700 cheaper and through the usefulness of the expanded front display. It's also IP68 rated and packs a stellar chip, beating rival flip phones.

From £1,049 from samsung.com/uk

REVIEW Issue 349, p70

EVERYDAY MONITORS

NEW ENTRY

NEW ENTRY

NEW ENTRY

Iiyama ProLite XUB3293UHSN-B5

32in 4K bargain, £429

from currys.co.uk

The fact that this 31.5in IPS monitor could compete so well against Eizo's alternative (see below) says it all. Great colour coverage in sRGB and DCI-P3, USB-C and RJ45 inputs, plus solid build quality add up to a bargain.

REVIEW Issue 357, p88



BenQ BL2790QT

A 27in, 1440p monitor that's packed with quality, from its brilliant OSD to several clever features designed to fight eye fatigue. Text and images look sharp and punchy, its USB-C docking capability is always welcome, and the speakers are surprisingly decent.

£270 from laptopsdirect.co.uk

REVIEW Issue 357, p85

Acer Verso B277 Ebmiprxxv

This is a basic but high-quality monitor, delivering colourful images across its 27in Full HD diagonal. You don't get USB-C docking, but it includes VGA, HDMI and DisplayPort inputs, plus a two-port USB hub.

£149 from tinyurl.com/357acer277

REVIEW Issue 357, p84

PROFESSIONAL MONITORS

NEW ENTRY

NEW ENTRY

NEW ENTRY

Eizo FlexScan EV3240X

Stunning 4K quality, £1,206

exc VAT from photospecialist.co.uk

With images that whack you between the eyes as soon as you lift it, fully assembled, from its box, this 32in 4K monitor is our top choice pick for anyone willing to make such a hefty long-term investment.

REVIEW Issue 357, p91



Eizo ColorEdge CG2700X

A brilliant choice for professional designers, whether working solo or in teams, thanks to its dedication to providing accurate colours across potentially years of life. It's also bang up to date for connectivity, with USB-C and RJ45 making it easy to manage, too.

£2,149 exc VAT from wexphotovideo.com

REVIEW Issue 357, p90

BenQ PD2706U

If you can't stretch to Eizo budget levels then this 4K 27in screen is definitely worth investigating. It has several features aimed at professionals, including a Hotkey Puck to switch between profiles, plus great coverage of the sRGB and DCI-P3 gamuts.

£333 exc VAT from scan.co.uk

REVIEW Issue 357, p86

WEBCAMS

Logitech MX Brio 705 for Business

Consistent brilliance for £219

from [logitech.com](https://www.logitech.com)

Consistent image quality in all lighting conditions coupled with top build quality and nifty features – such as a presenting mode for items on your desk – make this a fantastic all-round choice.

REVIEW Issue 356, p68



Aukey PC-W3 1080p Webcam

If the thought of spending £142 on a webcam has you spluttering into your microphone then you should consider this far cheaper but high-quality alternative. Its colours are low-key in comparison to the best, but it still produces a sharp and detailed image. **£13 from [ebay.co.uk](https://www.ebay.co.uk)**

REVIEW Issue 321, p72

Obsbot Tiny 2

This portable 4K webcam delivers for quality, design and sharpness, and it comes with a shedload of advanced features, including dynamic zoom and subject tracking. The only real downside is that it has a price that reflects its premium ambitions.

£329 from [amazon.co.uk](https://www.amazon.co.uk)

REVIEW Issue 352, p75

HOME OFFICE PRINTERS

Epson EcoTank ET-2830

Ink tank all-in-one for £250

from [epson.co.uk](https://www.epson.co.uk)

Don't expect flashy features, but do expect fast print speeds, high-quality prints, scans and copies, plus phenomenally low running costs – even after you've exhausted the 6,000 pages' worth of bottled ink that comes with it.

REVIEW Issue 353, p85



Canon Pixma TS8750

A fantastic choice for creative users that's equally at home printing photos as it is scanning artwork. Despite its high running costs, due to its reliance on cartridges, this is a superb all-in-one. **£159 from [printerbase.co.uk](https://www.printerbase.co.uk)**

REVIEW Issue 353, p86

HP OfficeJet Pro 9012e

So long as your print volumes aren't huge – the running costs mount up – this is a superb all-in-one for home office usage. It's fast, robust, prints double-sided and produces strong all-round results.

£208 from [printerland.com](https://www.printerland.com)

REVIEW Issue 353, p87

WORKGROUP PRINTERS

Canon Maxify GX6550

Ink tank all-in-one for £392 exc VAT

from [canon.co.uk](https://www.canon.co.uk)

Designed to fit in tight spaces, this all-in-one includes a highly effective ADF and backs it up with high-quality prints at 24ipm in our tests. Running costs are superb, too.

REVIEW Issue 350, p58



Brother HL-L9430CDN

This laser printer (not an all-in-one, so there's no scanning or copying functionality) is a great choice for a busy office, producing sharp black text and making a good job of colour graphics as well. All while doing so quickly with a competitive price per page. **£415 exc VAT from [printerland.co.uk](https://www.printerland.co.uk)**

REVIEW Issue 353, p84

Xerox B315DN

A fine alternative to the Brother and Canon, this mono laser multifunction printer produces superb results at great speed – 27.5 pages per minute in our 50-page test, which includes the spool time. It's similarly quick for scans, with a dual-CIS ADF to speed up double-sided copies.

£238 exc VAT from [printerbase.co.uk](https://www.printerbase.co.uk)

REVIEW Issue 341, p87

WIRELESS ROUTERS

Netgear Nighthawk RAXE300

Fast Wi-Fi 6E router, £350

from [amazon.co.uk](https://www.amazon.co.uk)

The RAXE500 is faster than the RAXE300, but in practice we doubt you would notice – this tri-band router still delivered speeds between 50MB/sec and 150MB/sec in our tests. And it's packed with features, too. At £150 cheaper than its bigger brother, we think it hits the Wi-Fi 6E sweet spot.

REVIEW Issue 341, p68



Netgear Nighthawk RS700S

Make no mistake – you won't get stunning speeds out of this Wi-Fi 7 router today. But if you must buy a router now and want future-proofing, this is a solid choice. But honestly, we would recommend that you wait.

£800 from [netgear.com](https://www.netgear.com)

REVIEW Issue 353, p76

Asus RT-AX59U

You can buy cheaper Wi-Fi 6 routers – such as the D-Link Eagle Pro AI R15 for £55 – but Asus' well-priced offering delivers strong performance along with lots of control and exceptional VPN support.

£125 from [uk.store.asus.com](https://www.uk.store.asus.com)

REVIEW Issue 350, p57

MESH WI-FI

TP-Link Deco XE200

Clever Wi-Fi 6E for £600

from [amazon.co.uk](https://www.amazon.co.uk)

There are cheaper Wi-Fi 6E meshes, but the XE200 wins for its superb download speeds, excellent coverage and the fact that older clients reap benefits of 6E, not just new ones. And a two-pack (code BOBKTDPMC8) should be enough for most premises.

REVIEW Issue 349, p65



Mercusys Halo H80X

A new subsidiary of TP-Link, Mercusys offers its parent brand's XE75 router some excellent value-for-money competition. Not as fast due to Wi-Fi 6 rather than Wi-Fi 6E, but it has all the bandwidth you need for everyday use and should deliver it stably throughout your house. There are plenty of features too. **2-pack, £161 from [ebuyer.com](https://www.ebuyer.com)**

REVIEW Issue 341, p71

Linksys Velop Pro 6E

Ironically, this Wi-Fi 6E router will get the most out of your non-Wi-Fi 6 devices thanks to its use of the 6GHz network for station-to-station traffic. And you only need two units for rock solid performance across a three-bedroom house. **2-pack, £380 from [amazon.co.uk](https://www.amazon.co.uk)**

REVIEW Issue 350, p54



BUSINESS WI-FI

Zyxel WAX640S-6E Wi-Fi 6E AP, £369 exc VAT

from broadbandbuyer.com

A nicely priced tri-band wireless access point ideally suited to businesses that want to provide the full range of wireless services. It's easy to deploy, wireless performance is good and Zyxel provides top-quality cloud management services.

REVIEW Issue 353, p100



Asus ExpertWiFi EBM68

Small businesses will find much to like with this simple-to-manage Wi-Fi 6 access point. AiMesh makes it incredibly easy to expand wireless coverage, performance is reasonable and it includes an impressive range of network security features. **2-pack, £540 exc VAT from amazon.co.uk**

REVIEW Issue 353, p98

Netgear WAX625

A great choice for SMBs seeking an easy wireless performance boost with minimum investment. This is an affordable Wi-Fi 6 AP with good speeds while Netgear's Insight provides smart cloud management services. **£224 exc VAT from broadbandbuyer.com**

REVIEW Issue 353, p99

NAS SERVERS

Synology DiskStation DS1823xs+

10GbE NAS, £1,413 exc VAT

from broadbandbuyer.com

This powerful eight-bay NAS is a great choice for SMBs that want plenty of capacity, features and performance at a reasonable price. The new DSM 7.2 software has security high on its agenda, and the icing on the cake is Synology's generous five-year warranty.

REVIEW Issue 346, p101



Qnap TS-h987XU-RP

The TS-h987XU-RP is a ready-made hybrid storage solution for SMBs. This rack-friendly package offers a great specification for the price, and Qnap's QuTS hero software scores highly for its wealth of data-protection features and business apps. **Diskless, £3,292 exc VAT from broadbandbuyer.com**

REVIEW Issue 344, p96

Synology DiskStation DS1522+

Small businesses that want a high-capacity desktop NAS at a good price will find Synology's DS1522+ a great choice. Performance over 10GbE is impeccable and the DSM software offers a fantastic range of storage features. **5-bay NAS, diskless £586 exc VAT from broadbandbuyer.com**

REVIEW Issue 344, p98

VIDEOCONFERENCING

Poly Studio X52 with TC10 Perfect middle man, £3,161 exc VAT

from meetingstore.co.uk

Ideal for businesses that want a professional videoconferencing solution for medium-sized meeting rooms. Video quality is excellent, speaker tracking fast, and the big choice of built-in VC apps makes it incredibly versatile.

REVIEW Issue 353, p102



Owl Labs Owl Bar

As a standalone videoconferencing room solution the Owl Bar has plenty to offer, with good video quality and super-smooth speaker tracking. It really comes into its own when paired with an Owl 3, though, as this unleashes a completely new dimension to your meetings. **£1,999 exc VAT from owllabs.co.uk**

REVIEW Issue 352, p99

Jabra PanaCast 50

This sleek cylinder delivers great video and audio quality, fast speaker tracking and a wealth of advanced features. Jabra's Xpress web portal offers smart remote management services, and the super-wide view helps make the PanaCast 50 ideal for all-inclusive meetings. **£867 exc VAT from uk.insight.com**

REVIEW Issue 354, p100

SCANNERS

Xerox D70n Scanner

Fast and furious, £765 exc VAT

from ballicom.co.uk

The D70n delivers a mighty scan speed together with a wealth of scan management tools and apps. Businesses that want a high-volume networked desktop scanner at an affordable price should put the Xerox at the top of their list.

REVIEW Issue 346, p99



Brother ADS-4700W

A fine choice for small businesses, with an impressive range of scanning features at a price that can't be faulted. Output quality is top notch and the versatile LCD touchscreen menus provide great walk-up scan services. **£355 exc VAT from printerbase.co.uk**

REVIEW Issue 346, p96

Epson WorkForce ES-C380W

An affordable choice for offices short on space. It delivers on its 30ppm speed promises, Epson's ScanSmart software offers plenty of management features, and its standalone mode makes it very accommodating.

£280 exc VAT from ballicom.co.uk

REVIEW Issue 351, p101

SERVERS

Dell EMC PowerEdge T350

Xeon E-2300 power, from £1,399 exc VAT

from dell.co.uk

Perfect for SMBs and branch offices looking for an affordable and powerful single-socket tower server. Along with support for Xeon E-2300 CPUs and lots of memory, it has a high storage capacity, plenty of expansion space and is sturdily built.

REVIEW Issue 335, p98



Dell EMC PowerEdge R250

With prices starting at around £850 exc VAT for a Pentium Gold CPU, and the option of Xeon E-2300 series chips from £1,461 exc VAT, this is a slim, rack-mounted alternative to the more high-powered T350 that's ideal for SMBs. **From £845 exc VAT from dell.co.uk**

REVIEW Issue 332, p98

Broadberry CyberServe Xeon E-RS100-E10

This represents a powerful hardware package at a price that will please small businesses. We love its low-profile chassis and the fine selection of remote-management tools. It's a great alternative to the Dell EMC servers also listed here. **£983 exc VAT from broadberry.co.uk**

REVIEW Issue 318, p96

SECURITY SOFTWARE

Avast Ultimate

Buy from retail and this is a bargain, with a solid VPN, anti-tracking software and handy detection fees on top of excellent protection. **10 devices, 2yrs, £30 from store.pcpro.co.uk**
REVIEW Issue 355, p84



G Data Total Protection

G Data provides straightforward, effective and inexpensive protection against malware and other threats to your system, making it a favourite despite its quirks. **5 devices, \$82 from gdatasoftware.co.uk**
REVIEW Issue 355, p87

Avast One Essential

Avast One Essential has the same malware-detection engine as our top choice, but for free. It even includes 5GB of VPN services per month and a few system optimisation tools. **Free from avast.com**
REVIEW Issue 355, p89

VPNs

NordVPN

NordVPN won our VPN Labs for the second time running thanks to its consistent, fast speeds, great security features and excellent support for video streaming. **£80 for two years from nordvpn.com**
REVIEW Issue 349, p86



ProtonVPN

The best free VPN service available, with quick speeds and unlimited bandwidth. The paid-for service isn't cheap, but offers a bunch of useful extra features that might just tempt you into coughing up. **Free from protonvpn.com**
REVIEW Issue 349, p88

Surfshark

The fastest VPN we've tested, and it's generally a good performer in our region-shifted streaming tests, too. Cancellation is trickier than it should be, but it's a great-value choice for heavy VPN users. **£56 for two years from surfshark.com**
REVIEW Issue 349, p89

PASSWORD MANAGERS

NordPass

This hassle-free option is a great choice for both personal and business use, with a competitive price matched with all the features most people need. **£1.89 per month from nordpass.com**
REVIEW Issue 350, p70



Bitwarden

Free for individual use and open source, the only important thing Bitwarden lacks is phone support: it works with virtually every device and browser, and the paid option is well worth £10 per year. **Free from bitwarden.com**
REVIEW Issue 350, p71

Keeper

A great choice for businesses thanks to its focus on security and a zero-knowledge policy, and if you need more options then Keeper has them. **Business edition, from £2 per user per month from keepersecurity.com**
REVIEW Issue 350, p72

ENDPOINT PROTECTION

Sophos Intercept X Advanced

Delivers a huge range of endpoint protection measures for the price. It's simple to deploy, device and user policies add flexibility, and seamless integration with the Sophos Central cloud portal makes management simple. **500-999 users, 1 year, £36.50 each exc VAT from enterpriseav.co.uk**
REVIEW Issue 351, p98



WithSecure Elements EPP and EDR

High levels of automation make WithSecure a great choice for SMBs that want endpoint protection on a plate. It's easily managed from the cloud, too. **100-499 devices, £37 each per year exc VAT from withsecure.com**
REVIEW Issue 351, p99

CLOUD STORAGE

ShareFile Premium

Cloud file-sharing features are on a par with many other solutions, but ShareFile Premium stands out for its generous 100GB file size support. Admin features and access security are extensive, and the new pricing structure makes it even more affordable. **£19.60 exc VAT per user per month from sharefile.com**
REVIEW Issue 355, p100



Tresorit Business Plus

Tresorit's strict zero-knowledge encryption policy, excellent value and ease of use make it a great choice for security-conscious SMBs. **£12.83 exc VAT per user per month from tresorit.com**
REVIEW Issue 355, p101

VOIP SERVICES

NEW ENTRY

3CX Phone System V20

Our top choice for businesses that want to manage their own VoIP system. It can be hosted in the cloud or on-premises, and has lots of new features. **Small Business, 10 users, £175 exc VAT per year from 3cx.com**
REVIEW Issue 357, p98



NEW ENTRY

TelephoneSystems.Cloud

A great choice for businesses that know what they want from cloud-hosted VoIP services, offering a wealth of features at a competitive price. **From £11 exc VAT per user per month from telephonesystems.cloud**
REVIEW Issue 357, p100

NETWORK MONITORING

Progress WhatsUp Gold 2023.1

Simple to deploy and offers an impressive range of network-monitoring tools. The choice of licensing plans makes it an affordable option for SMBs, and support teams will love its smart dashboard and NOC views. **Enterprise, 50 devices, £1,192 exc VAT per year from whatsupgold.com**
REVIEW Issue 354, p99



Paessler PRTG Network Monitor 23.4

A highly versatile network-monitoring package that delivers a wealth of information, and its all-inclusive price makes it a great choice for SMBs. **1,000 sensors, 1yr maintenance, £2,649 exc VAT from paessler.com**
REVIEW Issue 354, p98

REMOTE SUPPORT

IDrive RemotePC Team

IDrive's RemotePC Team will appeal to SMBs that want affordable cloud-hosted remote support for their offices and home workers. It's exceedingly simple to deploy, easy to manage and delivers tough access security measures. **First year, 50 computers, £172 exc VAT from remotepc.com**
REVIEW Issue 349, p98



NetSupport Manager 14

Delivers a wealth of support tools, including secure access to home workers, and licensing plans are good value. **1-500 systems, perpetual licence, £10 each exc VAT from netsupportmanager.com**
REVIEW Issue 349, p100

UTM APPLIANCES

WatchGuard Firebox T45-CW

Businesses that hate internet downtime will love WatchGuard's Firebox T45-CW. It provides a wealth of top-class security services, can be easily cloud managed and delivers seamless 5G WAN failover. **Appliance with 3yr TSS, £4,015 exc VAT from broadbandbuyer.com**
REVIEW Issue 354, p103

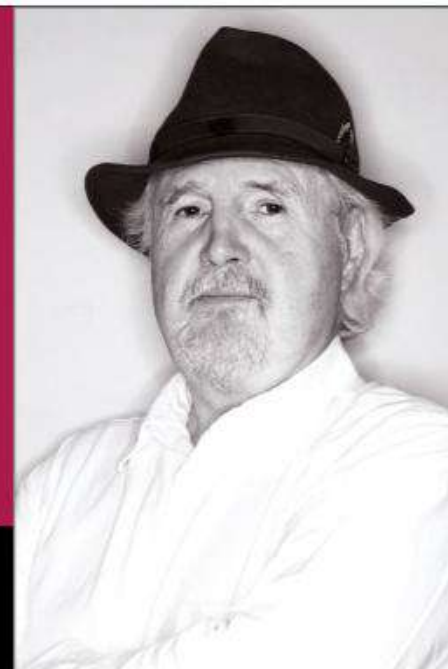


Zyxel ZyWALL ATP500

This desktop appliance gives sophisticated protection against zero-day threats, is easily managed and very good value. **Appliance with 1yr Gold Security licence, £1,191 exc VAT from broadbandbuyer.com**
REVIEW Issue 348, p99



Would the last one in the West please turn off the lights?



Dick Pountain is editorial fellow of *PC Pro*. If the West does fall, the good news is that he's pretty handy with chopsticks. Email dick@dickpountain.co.uk

Beware: technological progress is being squeezed on two fronts, with the rise of regulation in the US accompanied by a brain drain in academia

Unless you live life as an avatar in *Second Life* – yes, it still exists – it can't have escaped you that the world we live in has become much more interesting in recent years. And by interesting, I mean dangerous. What with epidemics, wars and deepfakery, the dotcom boom feels as remote as the Middle Ages.

A couple of recent incidents pushed me toward these reflections. The first was the news that the US Department of Justice (DoJ) was launching an antitrust lawsuit against Apple, for restraint of trade and monopolising the smartphone market. The DoJ's complaints arise from the walled-garden attitude that Apple has had ever since its very first days under Steve Jobs, with strict control over software development and peripheral manufacture so as to exclude smaller companies, and restrain the businesses of larger competitors.

Some of the charges are aimed at contractual restrictions, fees and taxes on the creation and distribution of apps; hindrance of apps such as Spotify, Netflix and Google Photo; restricting API access in the smartphone sector; excessive control over how smartwatches operate on iOS; and the restriction of cross-platform wallets on the iPhone.

I should emphasise that I'm far from being an Apple fanboy. The last one of its machines I owned was an Apple IIe and I was an enthusiastic early adopter of the open-architecture IBM PC, which is how I ended up at *PC Pro* some 30 years ago.

Wearing my other hat as a political commentator I'm an enthusiastic advocate of antitrust regulation and an

admirer of the American economist Thorstein Veblen. His theories about conspicuous consumption and the leisure class were influential during the last great bout of US antitrust action in the 1890s, which curbed the excessive power of "robber baron" industrialists such as the Rockefellers, Mellons, Carnegies, Vanderbilts and JP Morgan, ushering in a century of industrial growth and lessening inequality in the US (admittedly helped by two world wars).

That progress went into reverse in the late 1970s, to a point where even *Forbes Magazine* now believes regulatory action is justified. It reckons that "Apple's business will be fundamentally changed by this lawsuit", citing the example of Microsoft which "successfully rebounded from its own tumultuous years with regulators and has become the most valuable company in the world, ironically by becoming more open and embracing open source rather than shunning it".

If the DoJ wins this suit it will almost certainly then go after Google, Amazon, Facebook and the rest – but as *Forbes* points out, the case will run for years, and the Democratic Party has at best a 50/50 chance of retaining the presidency after this November. It's impossible to predict what a second-term, enraged Trump would do, but pursuing the case may not be high among his priorities. A horrible vision arises of Silicon Valley giants panicked into allying with him to create a doomsday authoritarian plutocracy, administered by AI robot warriors out of a Vaughn Bodé comic.

Which brings me to my second event. I'm a fan of the quirky German physicist and YouTuber Sabine Hossenfelder, who last week posted on her channel a remarkable lament about

“A horrible vision arises of Silicon Valley giants panicked into allying with Trump to create a doomsday authoritarian plutocracy”

why she left academic physics. She's already written a book, *Lost in Math*, excoriating her contemporaries for being seduced by pursuit of mathematical beauty away from experimental verification. In the video she paints a gloomy picture of a profession where young physicists have to tramp the world taking short-term posts, forced to churn out unimportant papers on topics enforced by credit-stealing superiors, all originality snuffed out. And addiction to ChatGPT and its ilk looks set to make this deadening toil worse still.

One more point. Regardless of whether Joe Biden or Donald Trump is POTUS this time next year, US relations with China will continue to deteriorate. America will keep on withholding leading-edge semiconductors from China and attempting to repatriate fabrication abilities from Taiwan to the continental USA. China will continue to build its own semiconductor research and fabrication (even if it doesn't actually grab Taiwan) and will prevent its best students from winding up in the USA. The decline that Hossenfelder depicts in Western academic physics will therefore become an alarming strategic deficit.

I'm not of the party that hungers for war against China, and I'm sceptical whether China and Russia could ally to start such a war, but I recognise that Western physics is likely to depend ever more on Silicon Valley and less on academia, which will make the handling of regulation a matter of some delicacy and diplomacy.

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“If the DoJ wins this suit it will almost certainly then go after Google, Amazon, Facebook and the rest”

Sorry Amazon, retail needs people – just ask Apple



Nicole Kobie is PC Pro's Futures editor. She was worried Apple wouldn't be able to fix her iPhone because it no longer sells the mini model, and the rest are too big for her tiny hands. Yes, she's still going on about this. X@njkobie

We may not need help when scanning our basket of groceries or packing our bags, but real-world shopping requires old-fashioned humans

Amazon Go has gone. Seven years ago, Amazon unveiled Go as a “new kind of corner store” that removed the hassle of queuing to pay. Plonk your groceries into a bag and, when you're done, leave – an AI-powered system dubbed Just Walk Out uses computer vision to identify your selections and charges your Amazon account. Pretty neat.

Just Walk Out's computer vision was aided by hundreds of in-store cameras, but items also had to be kept in specific locations, requiring in-store staff to keep shelves organised, and the whole process was watched over virtually by over 1,000 overseas workers. As it turns out, those people were doing more of the work identifying purchased items than the AI, leading Amazon to ditch the experiment. As a joke I saw online put it: in this case, as in many others, AI doesn't stand for artificial intelligence but “absent Indians”.

That doesn't mean Amazon's stores will now feature queues as long as Pret at lunch. Instead, Amazon is shifting to what it calls a “Dash Cart”, which lets customers scan purchases as they go. It's the same type of tech I used last

“In this case, as in many others, AI doesn't stand for artificial intelligence but ‘absent Indians’”

week at the big Tesco in Edmonton, so it's hardly cutting edge; it's really just a self-checkout you push on a trolley.

It's understandable that retailers are trying to slash staff costs, not least because so many struggle to hire at the moment. Filling jobs requires pay rises, so it makes sense to hand tasks such as checking out to machines and keep human staff for more advanced roles. Whether you agree with that or curse the invention of self-checkout machines – nothing is in the bagging

area, okay? – it remains the reality of retail in these dark times.

Unless you head to your local Apple Store, that is. Temples of technology, these bright white, double-height spaces also feature self-checkout facilities, but it's not for a lack of staff. I found this out recently after the camera on my iPhone stopped working.

After a virtual chat, I lined up an appointment at my local Apple Store's “Genius Bar” – a phrase that made me dread having to go in at all. What do you do when you arrive? Ask for the geniuses? Would I have to say these words aloud?

Thankfully, no. As soon as I stepped through the doors, a friendly chap with an iPad asked if I had an appointment – no mention of genius or bars – and directed me to a seat to await assistance. That came in the form of an efficient young woman who walked through the diagnostics before confirming that the camera component needed replacing.

It's been some time since I last had a phone I loved sufficiently to consider fixing it rather than replacing it; it was a gorgeous green Sony with a borked microphone. I loved that phone, but fixing it would have involved sending it away for weeks and hundreds of pounds. So when I was told I needed a new camera, I groaned and asked: how long is that going to take?

The response delighted me. I was given a pickup time of one hour and ten minutes. Think about what that means: Apple has staff in-store who can fix a phone right now. I'll manage my own checkout if you can offer that. (As I had forgotten to end my AppleCare subscription, all of this was at no extra cost, so no checkout required.)

Obviously, Apple's margins are a bit of a different story to a grocery store, so the motivations and financial impacts aren't comparable – for how

much we pay for iPhones, we should get good service when they break.

But we keep hearing that automation and AI are tools to remove boring and repetitive tasks. Amazon's example reveals that isn't yet possible in a real-world environment, at least

“We keep hearing that automation and AI are tools to remove boring and repetitive tasks. Amazon's example reveals that isn't yet possible”

not without remote workers overseeing the whole transaction.

And remote workers quietly powering AI is increasingly becoming a trend. When driverless cars in San Francisco aren't sure what to do, a remote engineer can help. Humanoid robots are avatars that are remote-controlled, be it to conduct work dangerous to a human, or, in the case of Prosper Robotics, to clean homes. OpenAI used low-paid Kenyan workers to clean up datasets to avoid racist and other offensive text from being generated; the AI model couldn't do that on its own.

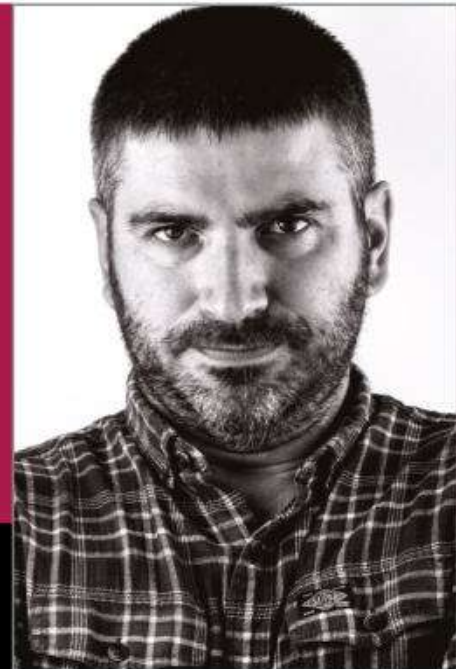
It's well past time that Big Tech admitted that people are still necessary rather than spending billions trying to engineer them out of existence.

And even if one task is successfully automated, such as checking out, there are still plenty of others that need doing. At the Apple Store, there was no queue to pay, but there was a door greeter, excessive numbers of sales assistants, a whole team of so-called geniuses, and repair staff in the back room – even a very enthusiastic guy teaching kids to code. It was noisy, but it was also the nicest retail experience I've had in a long time. If I didn't need the help of a person, I'd just shop online, after all.

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The fightback against punitive subs starts here



Barry Collins is a former editor of *PC Pro*. He only swears when there's a Y in the name of the day. [X@bazzacollins](#)

Companies think they have us on the subscriptions hook with hardware tie-ins, but there are ways to break free – and it's worth the effort

Nothing gets on my nipples like an unjustified price rise. So, when Amazon's Ring emailed in February, cheerfully informing me that it was whacking up the price of the Protect plan required to make its doorbells function from £35 to £50 a year, I fear I may have startled the neighbours with my verbal outburst. It made me so angry I may have startled the residents of Ottawa.

The Ring price hike is a classic case of price gouging, where a company reels you in with relatively cheap hardware for years and then turns the screw. Changing a video doorbell system isn't as easy as changing washing powder: you may have hard-wired it to your door, you may have invested in accessories and other Ring cameras, and then there's the convenience of Alexa integration. It's a pain to switch systems and Amazon knows it, which is why it's cranking up prices by £15 without even the pretence of extra benefits. Like it, lump it or leave. It didn't even try to offer me a discount before I cancelled online.

Consequently, I've been exploring subscription-free Ring alternatives. There's no good reason for a chuffing doorbell to even charge you an annual subscription in the first place. Yes, there's a cost involved in storing footage of your visitors on cloud servers, but that can be kept locally, with the added benefit of knowing the company's not handing it over to the police or whoever else demands a copy. If I'm going to be charged with disturbing the peace after receiving Ring emails, I'm sure as hell not going to be recording the evidence on my own doorbell.

“If I'm going to be charged with disturbing the peace, I'm sure as hell not going to be recording the evidence on my own doorbell”

I've looked at various options, including models from Eufy, Ubiquiti and TP-Link, the latter of which sent me one of its Tapo Video Doorbell Camera Kits for review. Very good it is, too. Great video quality, especially at night; dead easy to install; works with Amazon Alexa, albeit to a lesser extent. And crucially, the chime-cum-hub supplied in the box accepts microSD cards so you can store your captured footage locally and access it remotely, if you need to find out which fence the Amazon courier's thrown your package over.

But there's a doubt in my mind. TP-Link also offers a subscription service, similar to Ring's, where for about £30 a year you can store cloud footage. This also unlocks useful features such as “rich notifications”, where you get a still picture of the person knocking at your door in the mobile notifications, often saving you from having to wait a couple of seconds for the video feed to kick in.

As I type, this subscription is optional. But what if, after seeing market-leading Ring get away with it, TP-Link decides to turn the subscription thumbscrews too? There's no suggestion it will, but tech is tribal. How many times have we seen one-off purchases turned into subscription products over the years? I could go to the expense and hassle of switching, only to find I'm back in the same boat a few months later.

That exact same fear has cropped up with another of my tech favourites recently: Serif's Affinity software. The Affinity apps are brilliant alternatives to Adobe's Photoshop, Illustrator and

InDesign, without the stinging £50-a-month subscription fee. In fact, you can buy all three packages and get the iPad apps thrown in for £160. The only reason I

“When push comes to shove, these businesses will do whatever's best for them, not what's best for me. Pledges and promises are hollow”

don't use them as my daily drivers is because our rotten industry is so locked into InDesign and its proprietary file format, I'm practically handcuffed to Adobe.

But now Affinity has been bought by Canva (see p11) – an Adobe-alike that makes its money from (dramatic chord change) subscriptions. Canva and Affinity have attempted to allay the obvious fears by making a public pledge, splashed at the top of Affinity's website, insisting that it will continue to offer perpetual licences and will always price Affinity “fairly and affordably”, two words that are open to a vast range of interpretations.

There's a worrying caveat coming, too. “If we do offer a subscription, it will only ever be as an option alongside the perpetual model, for those who prefer it,” the statement says. “This fits with enabling Canva users to start adopting Affinity.”

Hmm... I want to trust that TP-Link will continue to let me use a doorbell without paying a ridiculous annual fee. I want to trust that Canva/Affinity are as good as their word, and will keep offering their superb software for a reasonable one-off fee. But when push comes to shove, these businesses will do whatever's best for them, not what's best for me. There's no binding legal contract here. Pledges and promises are hollow.

Let's hope the fears of this cynical old hack are not realised. But I've ordered a bulk load of ear defenders for my neighbours, just in case.

 barry@mediabc.co.uk

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Readers' comments

Your views and feedback from email and the web

Editor-in-chief Tim Danton writes: A huge thanks to everyone who wrote in about their mini PC experience in response to my request last month. Sadly we don't have space to include all the responses, but I'm grateful to Jeffrey Barfield, David Forth and John Knight for contacting us, in addition to the published correspondence below.

Life with mini PCs #1

I've always been a laptop user but, five years ago, after refurbishing my home office, I hankered after something more versatile and with a large display. I don't game or edit video, so I bought an Intel NUC barebones with a sixth generation Celeron CPU. I fitted it out with a couple of sticks of DDR3 and a SATA SSD.

Five years on and the NUC has never faltered – I am impressed with the build quality and quiet running. Unfortunately this model isn't certified for Windows 11, so it was time to upgrade to something newer. I picked up a refurbished tenth-generation NUC i3, which came with DDR4 and an NVMe M.2 SSD installed. I've just set it up and Windows 11 is running well and of course it's snappier than the Celeron.

Was I concerned about buying refurbished? Not at all, as my experience of running a NUC for five years was overwhelmingly positive. The old NUC will live on, however,

BELOW Mini PCs have a multitude of uses and are popular with PCPro readers



as I've just found a YouTube video showing how to repurpose it as the basis for a NAS. Another quality of the NUC will then come to the fore: extremely low power consumption, below 9W for most of the time.

So my advice is to consider whether you really need a bulky, noisy, power-hungry tower. **Roger Bullock**

Life with mini PCs #2

I've been an advocate [of mini PCs] for almost ten years. I first bought an Intel NUC with a Core i5-4520U, 8GB RAM and 128GB mSATA disk back in 2014, which was my wife's "daily driver" for many years until superseded in 2020 by an Asus PN50 with a Ryzen 7 4700U, 16GB RAM and 256GB SSD that's still in use today.

I repurposed her original Intel NUC as a home server running Linux to replace a desktop setup that was far too power hungry to be on 24/7. It now serves as a test/backup server with a myriad of old reclaimed disks in a Terramaster D5-300C 5-bay disk enclosure.

Our active home server is currently another Intel NUC with an i5-1340P, 16GB of RAM and a 512GB SSD with an Asus PN51 in a backup configuration.

Disks are in a Terramaster D6-320 for the active server and another

D5-300C for the standby, 8TB and 4TB respectively in RAID0 configurations.

The external storage boxes are USB 3.2 Gen 2 (10Gbits/sec) for active and Gen 1 (5Gbits/sec) for the backup, but speed has never proved to be an issue when primarily offering network services over 1GbE to the family.

The current active and standby configurations run servers for DHCP, DNS, Samba and Plex but are also more than capable of running virtual machines for firewalls/IDS/IPS (IPFire in my case), Wi-Fi routing (OpenWrt), monitoring (Zabbix) and Pi-Hole servers, thereby keeping "always on" power usage at a minimum. (The standby server normally sleeps but wakes once a day to clone updates from the active server.)

Sadly, my wife is soon to replace her PN50 with a laptop so I am intending to relegate her original NUC to the "still working but not currently needed" spares cupboard. It may yet have another life!

I was disappointed to hear that Intel was discontinuing its range of NUC systems but then relieved they were being passed to Asus which, in my opinion, has already proved its worth in this market segment.

In summary, if you don't need the portability of a laptop, a mini PC with external screen, keyboard and mouse is a much more usable system with the advantage that individual components can be replaced or upgraded as necessary. **Philip Styles**

Star letter

Headless PCs

I used to be a very technical follower and user of the PC market, but circumstances changed and I haven't looked at much until I perused the latest version of *PC Pro*.

A lot of the terminology hasn't changed too much over the past ten years, but some has – what is an "AI PC" and a "mini PC", and what are the best and average values of the current technical measures of speed, capacity, etc? A "get-up-to-date" column or article would be welcome!

In particular I read a letter and comments about mini PCs that might change my future thoughts. I am a totally



blind user and currently use a Windows tower PC without a display but with a Bluetooth keyboard and wireless headphones so I'm totally portable about

the house; I use the Jaws screen reader (an old 2020 version since I can't afford the ridiculous upgrade prices) that provides me with all the interaction I need. I have a tower PC since I used to require the power for C++ programming under Visual Studio, but this is no longer needed so I've started to think about replacements.

The whole Apple infrastructure is attractive because it incorporates the Voice Over screen reader out of the box, but can I

really change from Windows to macOS? I tried it many years ago and just found macOS weird! The idea of an NUC is intriguing, or what about a Chromebook or some kind of mini PC? This is where I have lost track of where we are now, and an article refocusing my knowledge would be welcome. **Allan Milne**

Editor-in-chief Tim Danton replies: Thanks for this, Allan. I'm not going to try to answer your question about which PC to buy (although we have a lot of coverage about mini PCs from other letters this month!) as I'm hoping that publishing this will get some response from readers who might well be able to help. A "what's changed" article could be interesting, so watch this space.



This month's star letter writer wins a Cherry KC 200 MX mechanical keyboard, worth £80, recipient of a five-star review and a PCPro Recommended award. Email letters@pcpro.co.uk

Life with mini PCs #3

I use a Microsoft Dev 2023 mini PC, a bargain at £579. It runs the Snapdragon ARM chip, comes with Windows 11 Pro, has 32GB RAM and 512GB NVMe storage, and it's silent in operation. But I have found the following minor irks.

There's no RTC battery, so unless you leave the machine connected to the mains it only remembers the last date/time you logged on. Frustratingly, it then takes an age to update the date/time when you log on, preventing access to Outlook as this detects a wrong date/time and won't load. My morning routine now involves turning the mini PC on and going to make a cuppa. By the time I get back it's ready.

Windows 11 Pro runs fine on ARM, but the x86 emulation mode is hit and miss. I installed a random collection of x86/x64 programs, and Lotus SmartSuite 9.5 from pre-2000 ran under emulation straight out of the box. As did MathCAD 14, Family Tree Maker 2011, GIMP 2.10.36, Audacity 3.4.2, LibreOffice 24.2, iTunes 12.13.1.3 and many others. However, Avast's free antivirus software won't work, even though the Microsoft store says it should, and nor does Blender 4.1 (the error pop-up says this may be due to a lack of OpenGL4.3 compatibility).

Likewise, VirtualBox wouldn't install on the ARM system under x64 emulation with a "fatal error during installation" reported. Fortunately, I was able to run WSL2, with Ubuntu installed. Running Linux terminal apps is generally fine, but graphical apps result in screen glitching, making it difficult to read or input data. Games just don't work under x64 emulation mode, even when run from Steam.

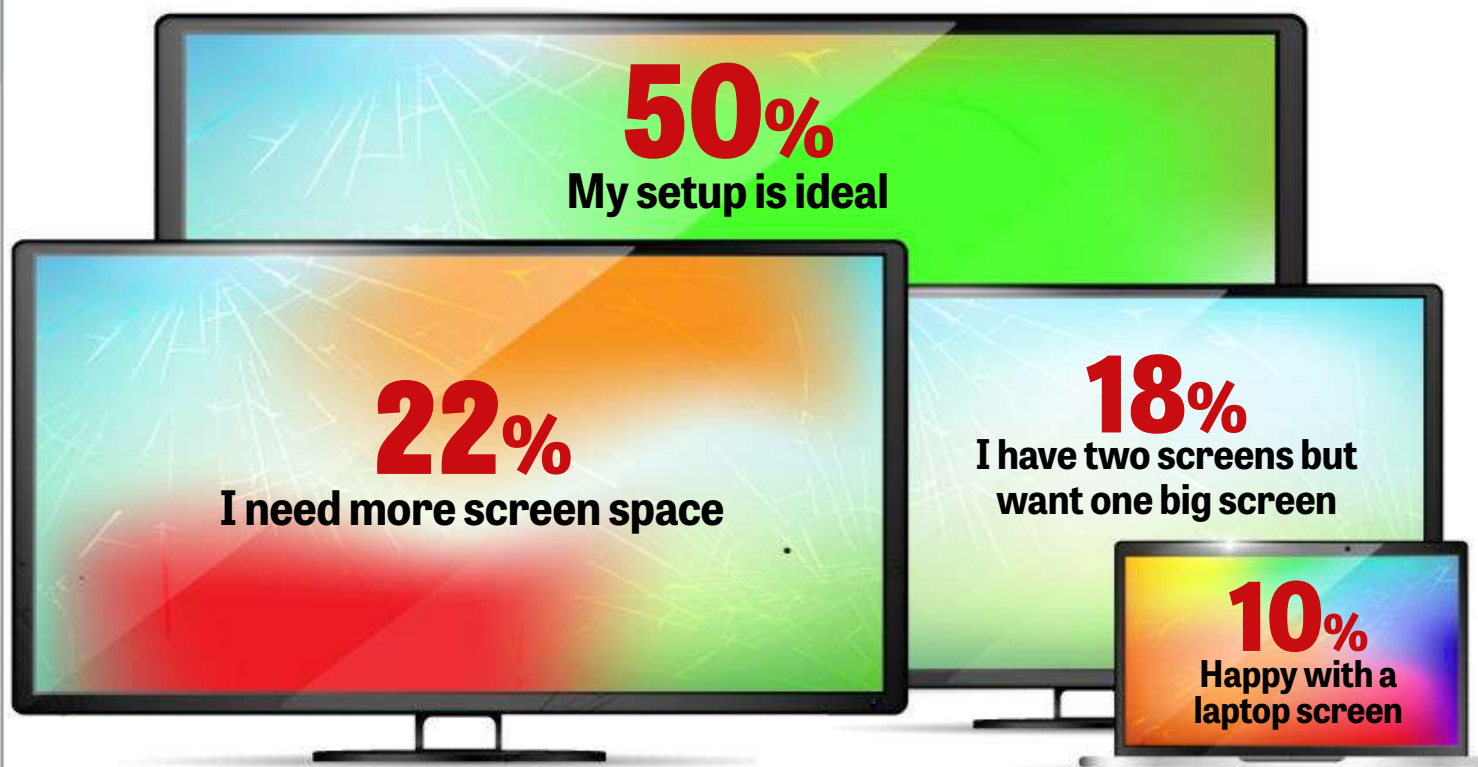
Fingers crossed, when Microsoft finally embraces ARM and the new Snapdragon Elite X chipsets later in the year, things will pick up.

Google Chrome whizzes along, as does most software written specifically for ARM. I am happy with my mini PC – I love the quiet, no distracting PC fan whirring or electricity metre whirring! The hybrid ARM/x64 environment is good from a cross-platform point of view, but more work on the x64 emulator is needed. The biggest issue is whether Microsoft really wants to embrace ARM.

I was initially tempted to buy an Mac mini, but to get 512GB of NVMe storage and 16GB RAM costs £1,399, nearly 2.5x as much – and Apple doesn't even do it in black! **Alan Wilson**

Readers' poll

To tie in with our monitors' group test on p78, we asked: which of these best describes your monitor setup?



It turns out that many *PC Pro* readers like to have many screens. "I have a three-screen setup," writes Paul Bamberger. "One large wide screen, a 'normal' 23in HD screen and the laptop. I do a lot of webinars and presenting online, so I share the 23in screen, run OneNote and my CRM on the big screen, and anything else required, such as PowerPoint presenter UI, on the laptop."

Nick Caulfield has a sophisticated setup involving "an anglepoise thing that supports three screens", with a fourth sitting behind. And then uses a USB switcher that means he can move between a desktop with four screens or a laptop with three.

Pete (@Brainy_Radio on X) says his monitor life is split into two. "At home I have the perfect setup," he said. "One monitor for email/Teams, main one for coding, one for viewing output and tweaking configurations. In my Civil Service office I only have a laptop and productivity is down to 20%. Three days in the office and two days at home equals decreased value for taxpayers." We hear you!

For some, such as Marcin Gorecki, a single big monitor does two jobs. For work, he connects his 15in laptop to it; for his own stuff, a private desktop. "The monitor works as a KVM," he explains, with the "laptop connected by one USB-C cable for power, mouse, keyboard and video signal, so there's no need for a docking station."

We'll give the final word to Alison Grant, who runs a repair shop in Kirkheaton with her husband Lee. "I have three 24in monitors for my desktop in the office," she said. "When working on my laptop I use the Duet app to use my iPad as a second screen. [It] makes such a difference to productivity compared to working on a laptop or single screen!"



“Usually I just run the UWD plus two HD screens, with PowerToys Fancy Zones to give me seven working apps. In extremis, however...”

Simon Hudson

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SLASH YOUR BILLS

BUILD YOUR OWN SMART HOME GRID



T

he standard electricity tariff in the UK is still an eye-watering 28p per kilowatt hour. In February, by “gaming” the variable price tariff he’s on and making the most efficient use of the solar panels and batteries in his home, *PC Pro* reader Rob Tweed managed to get his average price down to 9.8p – just over a third of what most people are paying at the most expensive time of year.

Rob’s setup is nothing short of ingenious. He uses software he coded himself to perfectly optimise when he draws power from the grid to charge his batteries, assuming the solar panels on his roof haven’t already done the job for him. The software pulls in data from a highly accurate weather forecasting service, so he knows almost exactly how much energy his solar panels will generate in the next few days and how much he’ll need to draw from the grid. When the sun doesn’t shine, Rob’s software ensures the batteries are automatically recharged when electricity’s at its cheapest – often at 2am in the morning, when he’s soundly tucked up in bed in his warm house.

Now, let’s be frank. Rob’s hand-coded setup is amazing, but probably beyond the majority of even *PC Pro*’s technically literate readership (although, as we’ll discover later, he’s hoping his software will soon be more widely available). But there’s

still a huge amount of home energy optimisation and automation most readers could pull off using open-source software such as Home Assistant. You don’t even need solar panels on the roof to benefit.

We’re at what feels like an inflexion point for home energy management. The variable tariffs are there, the software’s there, millions have solar panels on their roofs and batteries in their homes, but those things are rarely joined up. It’s within the gift of the technically literate to make that happen and benefit from energy savings that the mainstream consumer simply won’t achieve. We’re going to show you how you can use your tech knowledge to build your own smart grid and benefit from cheaper bills.

All the gear but no idea

Solar panel installations are once again soaring in the UK. Almost 190,000 households had solar panels fitted in 2023, according to the industry body MCS. That was the highest level in 12 years, figures not seen since the government scrapped the subsidy for installing panels in 2011. The energy crisis, the advent of heat pumps and the increasing usage of electric cars has prompted renewed demand for solar panels and batteries to store any excess energy generated. But few people are taking full advantage of this wonderful green energy infrastructure they’ve got strapped to their roofs.

There are huge savings to be made on energy bills if you can take control of your home grid.

Barry Collins reveals how it’s done



BELOW We all know it’s cheaper to charge your electric car at night, but that’s just the start



LEFT Batteries are an essential part of a sophisticated home energy setup

“duck curve” of electricity consumption that you’ll see in most homes and across the grid in general. There will be a rise in the morning as people wake up, a slight dip downwards during the day, and then a big peak as you enter early evening as cookers, lights and other appliances are switched on (see “Let AI reveal your energy consumption” on p30). If you squint at a graph of this, you’ll see the rough outline of a duck, hence the name.

Ideally, Britain’s energy companies would like to flatten that curve. Those peaks and troughs are hard to manage, and the times the country now relies on dirty coal or nuclear power are during those evening peaks when the renewables can’t supply enough to meet demand. That’s why you’ve seen those relatively recent “saving

sessions”, where energy companies have rewarded customers for using less energy during peak times – they’re trying to smooth the curve, lessening our dependency on dirty energy.

For consumers on variable tariffs, the big benefit of flattening the duck curve is cheaper bills. If you can use more energy overnight, when rates are normally dirt cheap, and use less during that early-evening peak when prices are at their highest, you’ll save money. Hence Rob’s desire to code a solution.

That was the situation software engineer Rob Tweed found himself in. He’d recently had solar panels installed, with batteries to boot, but wasn’t sure how best to take advantage of it. He started exploring how he could maximise his energy savings using the variable tariffs on offer from Octopus Energy. “It was very clear when the [solar panel] installation was done that most installers are blissfully unaware of all this stuff,” said Rob. “They just put it in, set it up and leave you to it. They really couldn’t help [with optimising energy use], so that’s where my adventure into this all started. It’s a real rabbit hole.”

Variable tariffs such as Octopus’ Agile tariff are still comparatively rare in the UK. They work on the basis that you pay more for electricity at times of peak demand, and less in the quieter hours when most folk are in bed and not running dishwashers, ovens and washing machines. There might even be the occasional time where you’re paid for using electricity, because the grid has more energy than can be stored and they need to get rid of it.

Such tariffs are largely designed for people with smart cars to charge. Most people aren’t going to get up at 3am to cook dinner or put the tumble dryer on (although we’ll come back to how the latter might be possible), but electric cars can be timed to charge during those off-peak hours when it’s much cheaper to do so. Still, Rob Tweed felt there was a bigger opportunity to optimise his new home energy setup than merely charging the car in the wee hours.



ABOVE Octopus Energy’s Agile tariff helps you avoid peak times

BELOW Rob’s app charges the batteries when needed and at the cheapest rates

“The big eye-opening thing for me in all this adventure was realising that it’s less about having solar panels on your roof and much more about having batteries,” said Rob. “Because they suddenly allow you to decouple your domestic usage from your grid power consumption. This is where being able to flatten the curve really comes in and batteries, in my view, are the really big important thing.”

When Rob talks of “flattening the curve”, he’s talking about the typical

Code green

Post-installation, Rob discovered that his inverter – the piece of equipment that turns the DC energy created by the solar panels into the AC electricity that the home can use, and stores the excess in the batteries – didn’t play nicely with off-the-shelf home automation systems such as Home Assistant. His inverter was made by a Chinese firm called Solis, which has huge market share even in Britain. “A third of us in the UK, all our daily electricity usage down to every five minutes is ending up in a cloud system based in China,” said Rob. “China knows more, probably, about electricity consumption in the UK than our country does. It’s astonishing that it’s even been allowed to happen.”

After a bit of research, Rob discovered that once you’ve signed a non-disclosure agreement with Solis, you can get access to its APIs. So he decided to use his expertise as a software engineer to code a solution





himself. “Once you’ve gone through that process, you can then set up a cloud-based system that remotely controls your inverter, all through standard web APIs to deliver JSON to and from your cloud-based system,” he said. “And that’s what I’ve spent the time building.”

There are two key parts to the software. The first is the integration with Octopus Energy’s Agile tariff pricing, so that the software knows in advance when the cheapest periods of electricity will be over the next couple of days. It can use these to charge the batteries during the cheapest half-hour slots available. The second vital aspect is the weather forecast feed from Solcast (solcast.com). This provides an accurate estimate of how much energy Rob’s solar panels are going to generate.

“You set up the parameters to specify exactly where you are, and the alignment of your roof and the angle of your roof,” said Rob. “They have satellites going around in space constantly monitoring the cloud levels and sunlight intensities all around the world. And by putting in those parameters, they can – and it’s ridiculously accurate – predict how much power you’re going to generate that day or the next day.”

That forecast is critical. If Rob’s software can see tomorrow’s going to be a cloudy day, it can get the batteries fully charged during the

ABOVE LEFT
Almost 190,000 UK households had solar panels installed in 2023

ABOVE RIGHT Coal and gas are still used to generate power at peak times

cheapest overnight slots to ensure he’s using as little grid energy as possible. On the other hand, if it’s wall-to-wall sunshine on the cards, he might need only one half-hour slot or not even need to charge the batteries at all. The software works this all out and controls the battery charging automatically, factoring in the average consumption patterns in Rob’s household for that time of year. January obviously has a very different energy profile to July (again, see “Let AI reveal your energy consumption” on p30).

Rob’s software also takes export fees into account – the amount you get paid for sending solar energy back to the grid. “If you’re on, like I am, their fixed export tariff, which gives you 15p per kilowatt hour for export, and you can buy at 7p overnight, then fill your battery as fast as possible, so that as soon as, on a sunny day, the solar is coming in, you can get into exporting as quickly as possible.”

As we noted at the beginning, the impact on Rob’s bills has been game-changing: an average of 9.8p per kWh in February and 12p in March (because there was less wind, so prices climbed). Compare that to the 28p per kWh most people are paying and the benefits are obvious.

But it’s not just tech-savvy consumers such as Rob who could benefit here, but the entire country. If software like Rob’s were controlling the solar installations in every home, we’d be a lot further down the path to solving our energy problems. “You look at the money pit that is Sizewell B,” he said. “I mean, it’s just horrific. You could spend that same amount of money putting battery systems in every home in the UK. And you’d flatten that curve completely.”

That’s one of the reasons why Rob’s company MGateway Limited (mgateway.com) is currently in talks with Solis, to see if he can sell his software application and let hundreds of thousands, if not millions, more customers benefit from the kind of savings he’s making.

Send for a Home Assistant

If you’re thinking, “all this sounds great, but I’m not a JavaScript developer”, don’t worry. You don’t have to be. There’s free software out there that can help you do many of the same things Rob’s achieved by writing his own code.

Home Assistant (home-assistant.io) is the software of choice for home automation enthusiasts. Like Rob’s software, it started life as a one-man hobbyist project. It came to life in 2013, founder Paulus Schoutsen told PC Pro, when he bought a set of the newly released Philips Hue light bulbs and discovered they had an API to control them. “I wrote a Python script to control them and I was like, well, now I can control my lights from my computer, but I need to do something with it. So, I had to turn on the lights when the sun was setting. Then I realised, you know what, I’m not at home and the lights are being turned on, so presence detection was added. But even when I was home, the sunset [time] is always too late in winter, so it has to be offset... and that’s how the ball started rolling,” he said.

BELOW Paulus Schoutsen created Home Assistant to control his Philips Hue light bulbs





Let AI reveal your energy consumption

If you've got a smart meter and are with one of the more progressive energy suppliers, it's possible you can download historic data about your electricity consumption, with usage broken down into half-hourly segments. With 48 different measurements for every day, however, you're going to have an awful lot of data points, and unless your Excel skills are on point, it's going to be one heck of a job to make any sense of that data. Time for a little AI assistance, perhaps?

I fed a year's worth of electricity consumption data from my Octopus Energy account into ChatGPT Plus to see what it could do with it. The data arrives in the form of a comma-separated values (CSV) file with only three columns, showing consumption (in kWh), start and end times.

ChatGPT Plus is quite happy to analyse CSV files, but as with all things ChatGPT, it's best to explain to the AI what it's dealing with. When I first tried to get ChatGPT to analyse the file, it had trouble working out the time format. So, to avoid tedious back and forth with the AI or, worse, incorrect analysis, start with a prompt such as the following:

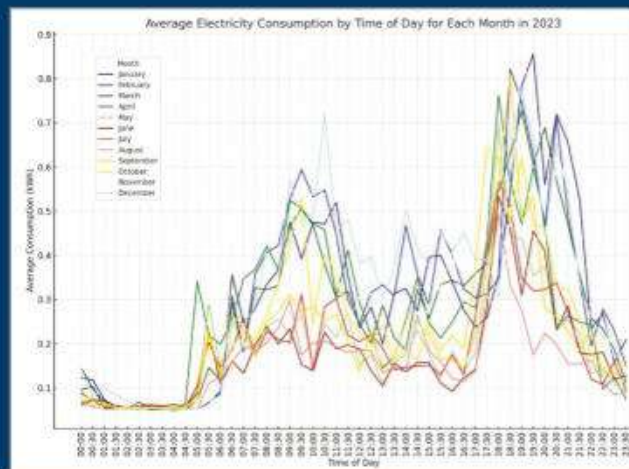
"The attached file is a CSV file showing my electricity consumption. If the field in the start columns says: "2023-01-01T00:00:00+00:00" that means midnight on 1 January 2023. If it says "2023-01-01T00:30:00+00:00" that means 00:30am on 1 January 2023. Do you understand?"

Remember to change the time format if required. By asking "do you understand?", ChatGPT should give you a call back to confirm it's grasped the data. For example, in my conversation, Chat GPT replied:

"Yes, I understand. In the 'Start' column, the timestamp '2023-01-01T00:00:00+00:00' represents midnight, and '2023-01-01T00:30:00+00:00' represents 00:30 AM, or 30 minutes past midnight."

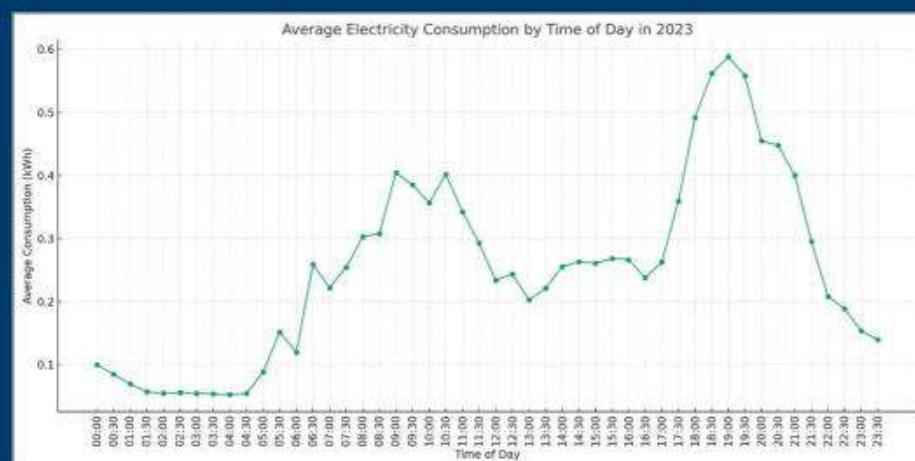
Now that's clear, you can start doing the clever stuff. For example, you can ask ChatGPT to "plot average consumption by time of day" and you should get a graph showing the "duck curve" that Rob Tweed mentioned, with a small peak in the morning and a much bigger early-evening spike. By the way, if you want the graph to be downloadable in PNG format, you'll have to specifically ask for it.

Average consumption by time of day is interesting, but it would be more illuminating to see how that changes throughout the year. So, try



LEFT ChatGPT can reveal the trends in your own annual electricity consumption

BELOW The ChatGPT-generated graph shows the "duck curve" of typical household electricity consumption



asking "can you plot average consumption by time of day for each month, on the same graph".

You'll likely get a very complex graph, with every plot in a different shade of green, that's difficult to interpret. So follow that up with:

"Can you label the months by name (ie, January instead of month one). Can you also apply the following colours: shades of blue for Dec, Feb, Jan; shades of green for Mar, Apr, May; shades of red for Jun, Jul, Aug; shades of yellow for Sep, Oct, Nov."

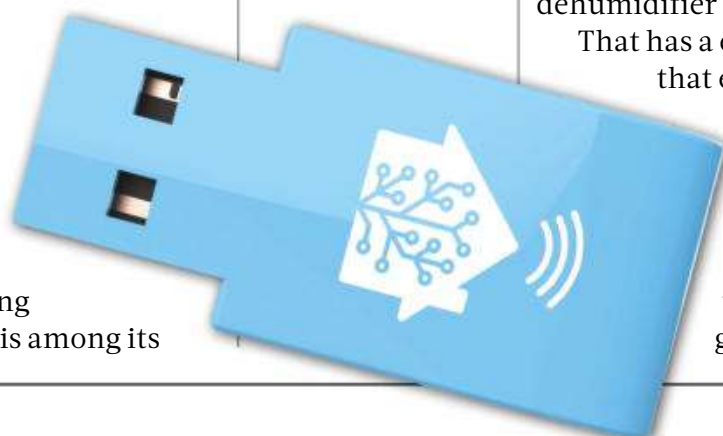
Now you should hopefully have a much more useful graph (as shown above) that clearly plots average consumption at different times of year, giving you a clear illustration of where you can make energy savings.

Home Assistant has since ballooned to become used by millions of people around the world. It can be installed on PCs, Macs or hardware as rudimentary as a Raspberry Pi 3. In fact, the company has started selling its own hardware pre-loaded with Home Assistant, so that consumers who aren't comfortable fiddling with virtual machines and the like have a plug-and-play alternative called Home Assistant Green (see "How to set up a Home Assistant" on p32).

Home Assistant's greatest strength is the vast number of devices it's capable of controlling. It has integrations for Philips Hue (of course), Amazon Alexa, SmartThings, Ikea Tradfri, Tesla, Nissan Leaf, Google Nest, Ring and hundreds more. If it's an internet-connected device, there's more than a decent chance that Home Assistant can manage it (the full list of integrations is at home-assistant.io/integrations).

Former *PC Pro* Real World contributing editor Paul Ockenden is among its

BELOW Home Assistant comes pre-installed on the SkyConnect dongle



fans. Paul showed me how he'd connected a vast range of devices in his house to Home Assistant, which he installed on a Raspberry Pi. Among the connected devices are his solar panels and batteries, his TV, his laser printer and even his smart cat flap, where Home Assistant keeps an eye on the battery level.

Paul gave me a couple of examples of Home Assistant automations he uses to maximise energy efficiency. The first controls the dehumidifier in his utility room. When the humidity sensor detects humidity is above 62% and the charge in his batteries is above 40%, Home Assistant automatically switches on the dehumidifier. The script can be a little buggy, according to Paul, so he sets it to run again after a minute just to make sure the dehumidifier definitely comes on.

That has a corresponding routine that ensures that no energy is wasted when the dehumidifier has done its job. So when humidity drops below 55% or if the charge in the batteries starts getting low, Home

Assistant switches the device off. "I've got loads of little things like that running," said Paul, exemplifying how, once you've created the automations, things just look after themselves and you can make lots of small energy savings that could add up to big savings on bills.

Paul also takes advantage of the Solcast weather forecast to ensure he's getting maximum utility from his batteries, much like Rob Tweed's software does. "Today is going to be 11.49 kilowatt hours," he tells me as he noodles around in his Home Assistant dashboard. "Tomorrow is a bit better, then the next day is going to be pretty useless in terms of solar. So, using those I can start to automate how much I'm going to charge the batteries and all those kinds of things."

Any of Paul's former readers will know he's not afraid of getting his hands dirty with a bit of code, but he insists that the level of programming needed for Home Assistant shouldn't worry any *PC Pro* reader. "You do have to do a bit of programming and a bit of coding, but there's a visual code editor, a bit like Scratch or some of the more simple visual coding software."



ABOVE You can maximise your usage of green energy

And it's not only energy saving that Home Assistant comes in handy for chez Ockenden. "There's a thing called 'hacks', which is like user-generated stuff," he said. Here he found a feed which "will even tell me which day my bins need emptying. And I've got those set up on a little E Ink display in the kitchen, so I can just glance up at that E Ink display and see it's recycling tomorrow."

Software that can end arguments over which bins to put out? That might be worth more than Rob's electricity-bill saving app...

Controlling everything

The fact that Home Assistant can interact with a huge range of home equipment is no accident. Schoutsen realised early in the software's development that he would need to rely on input from the user community if he was to create an app capable of controlling almost everything in the home. "I'm not personally adding those integrations," he said. "I can only add the things I have in my house because otherwise I couldn't test them."

With most software projects, the developers would want to test a third-party integration to make sure it works properly first, but Schoutsen has grown to trust his community of contributors. "Normally, you wouldn't accept code that you don't really know works, but in our case, we



ABOVE Paul Ockenden controls a range of devices via Home Assistant

do it because that first step of adding like the authentication method to interact with a set of devices is the hardest part. Then if there's a bug, it's easy to fix if the basic foundation is already there."

He goes back to the example of Philips Hue light bulbs to demonstrate how trusting third-party code isn't a huge problem. "If a new light bulb comes out with a new feature that we don't support, it might still be able to turn on or off," he said. "Somebody will report an issue and then somebody else has that light bulb and knows how to code can fix it, so they will add support for that feature."

That trust in the community seems to encourage participation. "Today, we are the second most active open-source project in the world," Schoutsen claimed. "We had 17,000 people working on the system in the last year."

exactly renowned for open standards – such as Apple, Amazon and Samsung – have put their collective weight behind the Matter standard, giving Schoutsen even greater confidence that Home Assistant will continue to thrive. "The adoption of Matter is crazy," he said, "because you can all of a sudden, today, make a product that will work out-of-the-box with anyone using Google Home, Samsung, Apple, every little home system. That has never before been the case, so your addressable market is bigger."

Eventually – whether it's one of the big energy companies distributing software such as Rob Tweed's app, or a firm such as Google or Apple really taking it more seriously – home automation is going to become mainstream. The potential benefits for both consumers and the planet are too huge to ignore.

In the meantime, it's clear that it's the people willing to hack stuff together on their own home networks who are the ones that benefit. The geeks might not inherit the Earth, but we're the ones who can do our bit for the planet and cut a sizeable chunk out of our energy bills.

Your next steps

We can't give a blanket recommendation about what to do because everyone's situation is different. For instance, I would love to install Octopus solar panels, but a roof extension has caused complications; my next step is to look at alternative solar panels. Your next step will depend on many factors: where you live, how long you intend to stay there, how much electricity you use, whether you have big energy drainers such as an electric car or heat pumps – the list goes on. But our guide to using Home Assistant overleaf should certainly give you inspiration.



How to set up a Home Assistant

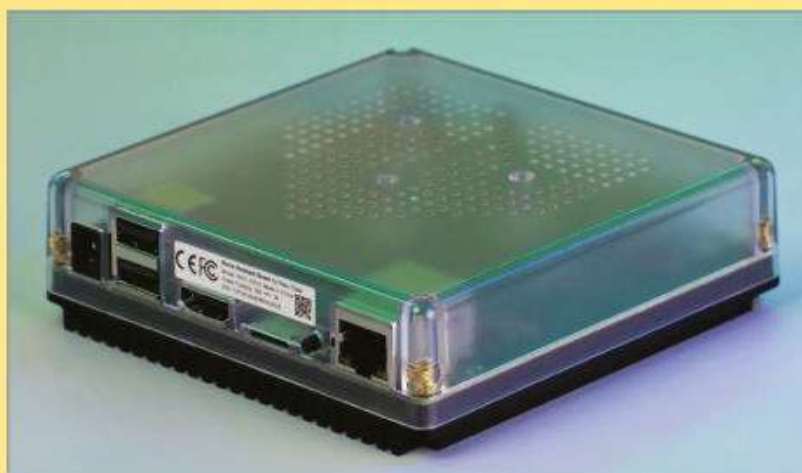
You don't need solar panels and batteries to get something from Home Assistant – it has a huge range of potential uses. Here's how to get cracking with the software.

Home Assistant is the software of choice for those who are hacking together their own smart home. It works with a vast swathe of smart home kit, as well as more mundane devices such as TVs, printers and laptops, bringing all the internet-connected devices in your home under one umbrella. From there you can start to do smart things, such as automating when devices are switched on, or making best use of the energy stored in home batteries, for example.

Installation

Smart Assistant is free software that can be installed on all manner of hardware: PCs, Macs, Raspberry Pi units and even NAS drives. Given that you're going to want Smart Assistant running 24/7, it's best not to install it on an energy-guzzling gaming PC, though. Something like a low-powered Pi or an always-on NAS drive makes much more sense.

If you can't be doing with installing it yourself, the company behind Home Assistant – Nabu Casa – sells hardware that comes with the software pre-installed. For example, I was sent a Home Assistant Green, a compact unit that looks like a Raspberry Pi trapped in a semi-transparent Perspex box. It's not a Pi, but a Rockchip RK3566 system-on-a-chip with an ARM Cortex-A55 CPU, 4GB of RAM and 32GB of eMMC flash storage. All you do is plug it in, connect it to your router via the supplied



ABOVE Buy the Home Assistant Green for a simple, low-power solution

Ethernet cable and you're away. The Green costs £86 (from tinyurl.com/357green) and the optional SkyConnect (£32.50) is a plug-in dongle that adds a Zigbee and Thread radio to the package, letting you control any devices within range that use either of those two standards.

Accessing your Home Assistant

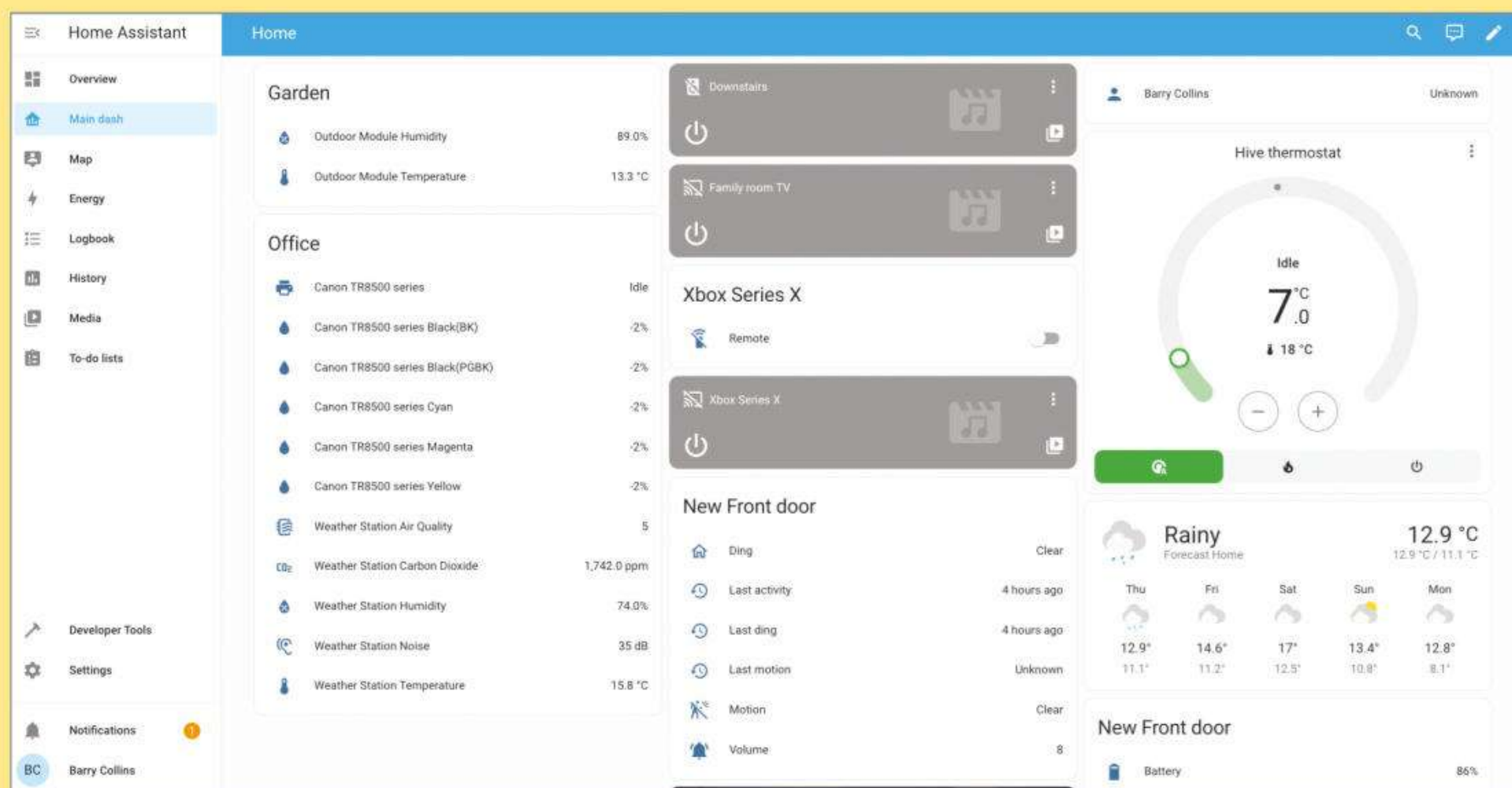
You access the Home Assistant via a web interface or using the mobile apps for Android and iOS. For setup and more complicated tasks, such as creating automations (we'll come to this shortly), I'd definitely advise you to use the web interface rather than the more cramped mobile screens.

Talking of the web interface, you're advised to access it via <http://homeassistant.local:8123> in the startup documentation. However, I found this

unreliable, and judging by the support forums so do many others. It's much better to find the IP address of your Home Assistant (your router's admin panel should reveal this) and then access the Home Assistant via <http://192.XXX.X.XX:8123> (insert your own IP address before the :8123 port address).

Once you've created your account, Home Assistant will try to find all the smart devices connected to your network. Don't lose heart if it only automatically detects a fraction of your smart home devices, as you'll be able to add others manually.

However, for the time being you'll be thrust into the main Overview dashboard, where you should see cards for the devices that Home Assistant has managed to identify. You might want to start getting your hands dirty and editing this dashboard, re-arranging things to more how you like them. However, Home Assistant's documentation advises against this, urging you instead to create a new dashboard by going to Settings | Dashboards and working from there. Personally, I think this advice is probably overkill, an abundance of caution to prevent you accidentally screwing up the dashboard where all new devices are added. However, if you do want to edit that main Overview, you first need to "take control" by clicking the pencil icon at the top right of the screen, then clicking the three dots and selecting "take control".



Moving cards around the dashboard isn't the most intuitive of processes. Instead of being able to drag and drop cards where you want them, you have to order them by number in a grid system. We haven't got room to go deep into it here, but there are ways to make the dashboards cleaner, such as adding tabs for specific groups of devices (such as keeping all your cameras in one tab). Before fiddling with your dashboards, it's well worth reading the Home Assistant documentation on the subject at tinyurl.com/357dashboard.

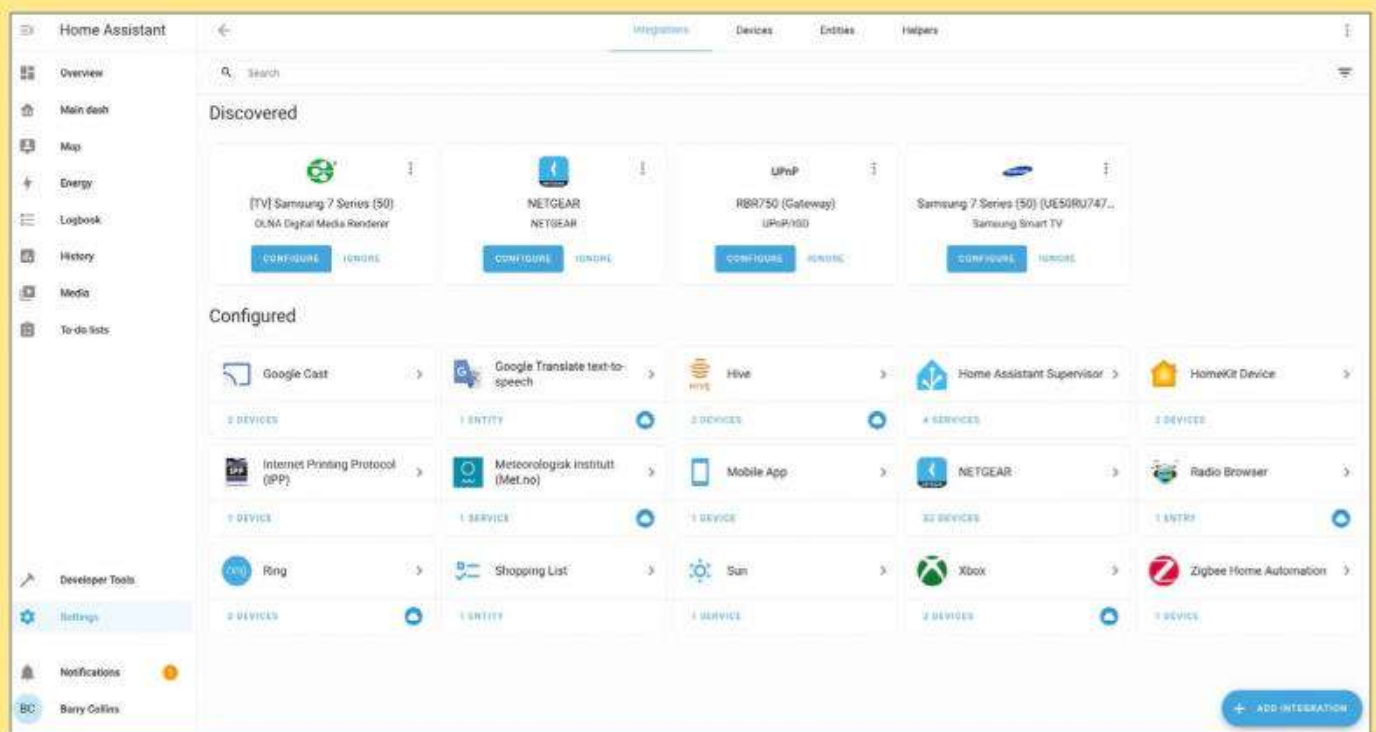
Adding new devices

Chances are that Home Assistant didn't pick up a bunch of your home devices in its initial sweep, so how do you go about adding those? For this, you need to dive into Settings | Devices & Services.

A fiddle around in this screen might already show devices that haven't been added to your dashboard, but you'll more likely find success with the Add Integration button at the foot of the screen. Integrations are grouped by brand name – you'll find integrations for Blink cameras, Fritz!Box routers and Ring doorbells and cameras. And hundreds more besides.

Once you've added an integration, you'll often be asked to log in with your credentials to access the devices. You'll then be presented with suggested cards that you can add to your dashboards. For example, the suggested Ring cards include a video window of your most recent doorbell recording and status updates on the battery level.

The list of integrations is long, but not exhaustive. And there can be some weird exceptions. Even though there's an integration for TP-Link, for example, my TP-Link Tapo smart plugs aren't included. I also have Philips Hue smart bulbs in the house, currently controlled via Amazon Alexa devices and not the dedicated Philips Hue Hub that its integration wants to talk to. It is possible to control these standalone lights using the Zigbee radio, provided they're within range, but this involves disconnecting



ABOVE Home Assistant will try to find all the smart devices connected to your network

them from Alexa and re-pairing with Home Assistant, meaning it's an inconvenient choice of one or the other.

Automations, scenes and scripts

Once you've added as many devices as you can find in the home and cleaned up your now sprawling dashboards, it's time to get stuck into the clever stuff.

Let's start with automations, which is where things start taking care of themselves. You might, for example, create an automation that switches on a hall light when someone rings your smart doorbell. Or one that automatically switches off your central heating when you're not at home (Home Assistant can check whether each occupant's smartphone is connected to the home Wi-Fi to determine whether they're in or not).

Automations can have multiple triggers. So, for example, you might set the lights in a room to switch on only if a motion detector is triggered and your smartphone is at home, to prevent a cat or dog triggering lights to come on when you're not there.

Automations are fairly simple to create. Go to Settings | Automations and Scenes

and click Create Automation. From there it's simply a case of selecting items from the dropdown menus.

You'll be shocked to hear that same menu is where you find scenes, which allow you to put different devices into a specific state for a specific purpose. If I were a Twitch streamer, for example, I might have a "streaming" scene where I can click an icon in a Home Assistant dashboard and have the lights turned up to full brightness and the noisy air conditioning switched off. You could have a "Netflix" scene for the lounge where the lights are dimmed and the TV is switched on.

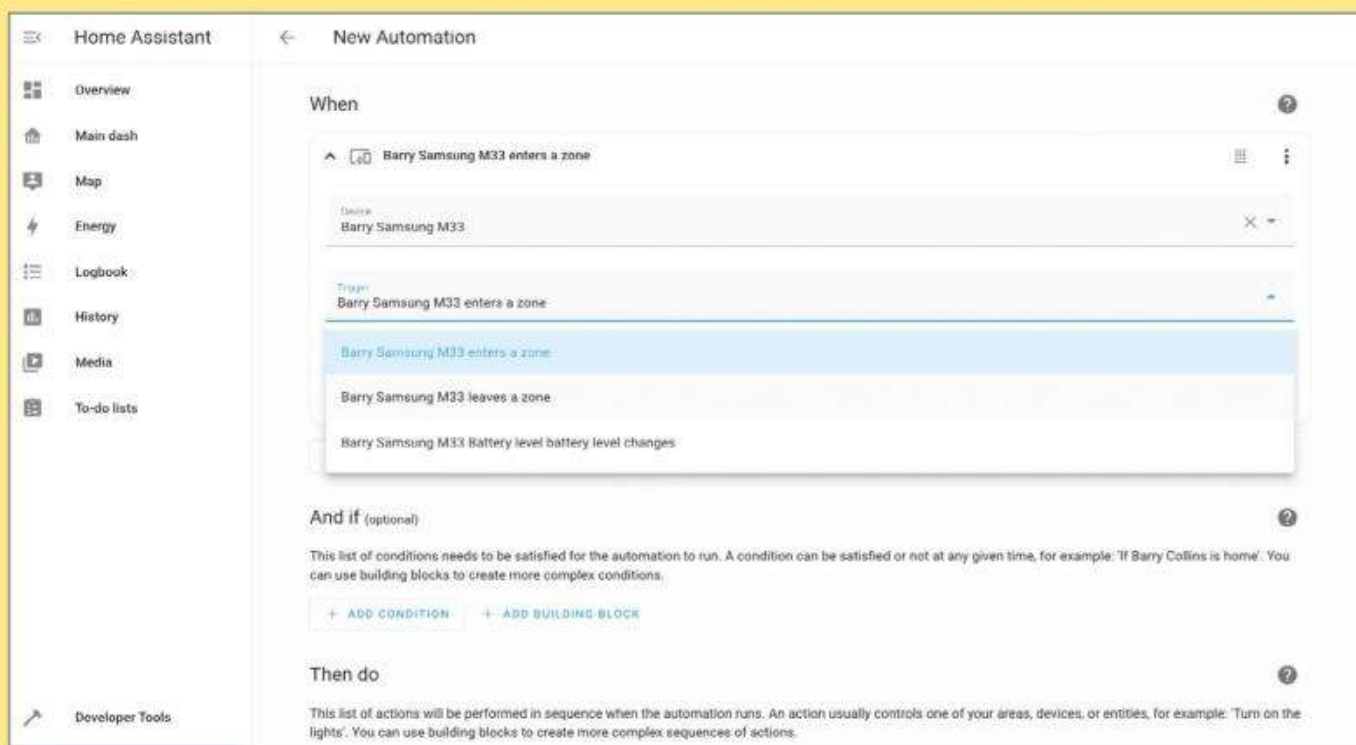
Scripts are where things start to get more complicated. They can be called manually (by clicking a button in the dashboard, say) or as part of an automation. They allow you to do more complex things, such as putting a pause between commands. So, for example, when Paul Ockenden mentioned that he has an automation that switches on his dehumidifier when humidity reaches a set level, he uses a script to ensure the process is repeated after a set time, because the automation can be buggy. Scripts can also be used to send notifications to your phone if you've gone out and left a window open or the heating on.

Again, we haven't got space to dive into scripts too deeply here, but the official help page is a good place to start learning; see tinyurl.com/357scripts.

And there's more...

Cliché ahoy, but I really have only scratched the surface of what Home Assistant is capable of here. I haven't discussed the community "hacks" that add support for yet more devices, I haven't mentioned the extra add-ons that let you turn the device into a network-wide ad blocker or a WireGuard VPN tunnel, and I haven't mentioned the developer tools.

It's all free, too, unless you want remote access to your Home Assistant. Nabu Casa charges £6.50 per month for that or £65 per year. There's a 31-day free trial to see if you really need it. ●





7 HABITS OF HIGHLY EFFECTIVE IT PROS

The *PC Pro* team combine their collective wisdom to create seven tips for keeping on top of your IT game

1 Think long term – Jon Honeyball

Short-term thinking is the absolute enemy of effective working. I have lost count of the number of times I've completed a firewall audit, only to find an incoming route punched through the firewall because the CEO wanted to run some weird software from home for a weekend. And that was two years ago, and yet nobody has gone back and plugged the hole.

Dropping that cheap switch into the network because the cable wasn't long enough is fine as a short-term fix – until this becomes a major route of traffic through your office. And the cleaner unplugs it to get the vacuum to work.

How many times have there been servers collecting dust under the desk that someone has forgotten about? Or a virtual machine hosting a mission-critical infrastructure component, and yet nobody knows what it does, who owns it, or what the login credentials are? Or when it was last patched? Or even who was responsible for this process, because Fred left two years ago and you're sure he was the one who knew. Or was it Michelle?

It's imperative to have an active hardware replacement process. Hardware breaks all the time. Keeping something running just because it hasn't broken yet is absolutely not the risk profile analysis that helps you when it does actually die. This might be tomorrow, next week or in two years' time, but it will break.

Accountants hate this, because they see the capex and are certain that there are better ways to spend the money. The whole capex vs opex costing basis can be anathema to an organisation that is trying to manage risk and processes in the long term. Key indicators here are laptops that are more than four years old, servers that are older than six, and hard drives that have been



ABOVE Don't wait for things to stop working before taking action

spinning 24/7 for years with little thought about failure modes.

Any time you're forced to make a short-term decision to fix an emergency issue, you should ask the obvious next question – what will be done in the short term to unwind this, and put in place a long-term solution? Fire-fighting is part of business. But it shouldn't be your business.

2 You don't need a lawyer to know right from wrong – Rois Ni Thuama

New tools means new rules. Or does it? Trying to grasp the intersection of law and new technology seems like a tall order. Especially when it appears as though that new tech has put turbo-boosting skates on and is coming at us, head first, like a drunk at a roller derby.

You need to be confident that you're in good shape to handle this.

Most of us can demonstrate that we have a pretty good moral compass and an astute grasp of the fundamentals of the role of law by pointing out two things. First, the vast majority of people have managed to surf through life without ever being arrested, never mind being prosecuted or convicted of a crime, despite never having formally studied law. This is good news.

The news gets better. Second, our jury system – which relies on ordinary citizens noodling over the facts of a case (often complex) and considering

those facts against a backdrop of impenetrable legal jargon and returning (for the most part) sensible results – is a testament to our community made up of ordinary men and women, good and true.

Heavens to Murgatroyd, I hear you gasp, what does that have to do with tech tools taking off at a gallop? Well, legitimate concerns about how these whizzy widgets and whatnots are integrated into our world, how they might impact users, redefine the nature of our association with our family, friends and the wider community should be raised and must be addressed.

My view in brief is this: with our almost intrinsic understanding of what it means to operate within the law, we're in pretty good shape to meet this difficult conversation about new technology head on. Provided, of course, we grasp the nettle. The truth, however painful, must remain central.

The role of law is multifaceted, encompassing various functions aimed at promoting order, justice and the protection of individual rights. As we look at how these smart new tools might bump up against the old order, provided we stay true to what we know is the right thing to do, we'll enjoy the benefits of new tech without a tsunami of legal problems.

3 Think defensively – Davey Winder

When it comes to cybersecurity, I often turn to an instruction manual written more than 2,000 years ago. Sun Tzu's *Art of War* is more useful than you might think in the cyber age.



BELOW Do the right thing and new tech won't land you in court



Tzu says that the art of war “teaches us to rely not on the likelihood of the enemy’s not coming, but on our own readiness to receive him; not on the chance of his not attacking, but rather on the fact that we have made our position unassailable”.

Most security professionals will admit that an attack by cybercriminals or other malicious entities is inevitable, so the best defence is not offence but thinking and acting defensively.

The defensive mindset starts at home and transfers into the workplace, constantly placing obstacles in the path of the would-be attacker and disrupting the kill chain of Reconnaissance, Weaponisation, Delivery, Exploitation, Installation, Command and Control and Action on Objectives.

I always use a secure password, and where possible, something other than my well-known email address as a username. Both can be randomised and are all the better for it. I employ a password manager not only to create credential strings but also to do away with the need to memorise them. An attacker can still use these if they become compromised, so I don’t reuse them (this lowers the odds of them ending up in a database breach) but I do use two-factor authentication.

Enabling 2FA is the first thing I do after signing up for anything; it’s not a guarantee against account compromise, but it does throw a large spanner into the attempted breach and works most of the time.

ABOVE Document everything to save time down the line

I effectively combine login credentials and 2FA by using a passkey, where possible, which can also be stored by your password manager.

Attackers looking for another way into your business will often search for known vulnerabilities in your operating system and applications. Thinking defensively means I don’t hang around when there are software updates and security patches, closing the window

of attack opportunity as quickly as possible. I adopt this way of thinking across my entire tech landscape from laptops to smartphones, tablets to televisions, security cameras to routers. Make it a habit; you can thank me later.

I’m not a fan of the “zero-trust” buzzword, but I don’t trust anybody until they’ve earned it. Even then, my defensive mindset means I won’t click on links in emails, open unsolicited attachments and so on. It’s another habit you should acquire.

I never rely upon one defensive process but rather look back through history where the king’s castle placed multiple hurdles in front of an attacker: a moat, a portcullis, ridiculously thick walls, slits for archers to fire out of and so on. I apply the same thinking to my networks, layering the defences for depth.

This makes it harder, but not impossible, for an attacker to be successful. After all, as Sun Tzu said: “One need not destroy one’s enemy; one need only destroy his willingness to engage.”

“An attack by cybercriminals is inevitable, so the best defence is not offence but thinking and acting defensively”

BELOW A physical passkey can help keep things secure



4 Document everything – Barry Collins

I’ve done it a dozen times on my own websites. Something’s not working, so you Google your way to a piece of custom CSS that fixes the problem. Job done. Except you omit to document or comment on the changes you’ve made. So when another problem arises a couple of months down the line and you’re staring at a bit of code wondering what the hell it does, you’re none the wiser.

Even as a journalist who spends 75% of his day writing, documenting code is boring as hell. But it’s necessary drudge work, the two-minute job that’s going to save you two hours further down the line. Even if it’s not immediately obvious why.

For some companies, it’s almost sacrosanct. Two years ago, I spent a couple of weeks working inside the tech support team of a very well-known internet company that has a great reputation for customer support. A large percentage of customer problems were solved by referring back to how a colleague had solved that same issue for another customer, and that all boiled down to careful, methodical documentation (and a good search engine). The company rightly considered it a complete waste of time if you solved a customer’s tech problem but failed to document it properly.

So much IT knowledge is trapped inside employees’ heads. It’s no good there. Heads follow their owners out of the door when they leave the company. Document everything, even if it’s unlikely you’ll ever need it.

5 Listen, ask, listen, then repeat if required – Lee Grant

History is peppered with figures whose brilliant minds caused them to do dumb things because they hadn’t understood. If I’ve learned anything of the art of repair, it’s the importance of listening and asking.

Repair is a service, and those who only listen to their customers will fail badly. The language of computing is full of jargon and confusion, so questions must be asked and answers absorbed in order to decode the problem that’s being presented.

The trapdoor through which experienced people will fall is complacency. When a customer places their laptop on the counter and explains why they’ve brought it to

you, just listen, then ask. You may know what the problem is. You may have seen the issue several times, but if you don't listen or ask questions, you'll make assumptions, which is when errors creep in.

Always remember you're working for someone else, whether that's in repair or a tech support role. You may recognise a dozen quirks on a machine but, without asking questions, you'll never ascertain which are genuine faults or just user preferences. Repairers who impose their own predilections for toolbar locations, browser plugins and mouse speed are guilty of a great disservice to their clients. Ask questions, listen to the answers, then ask again. Only then can you find genuine faults.

The writer Neil Gaiman said: "Remember, when people tell you something's wrong or doesn't work for them, they are almost always right. When they tell you exactly what they think is wrong and how to fix it, they are almost always wrong."

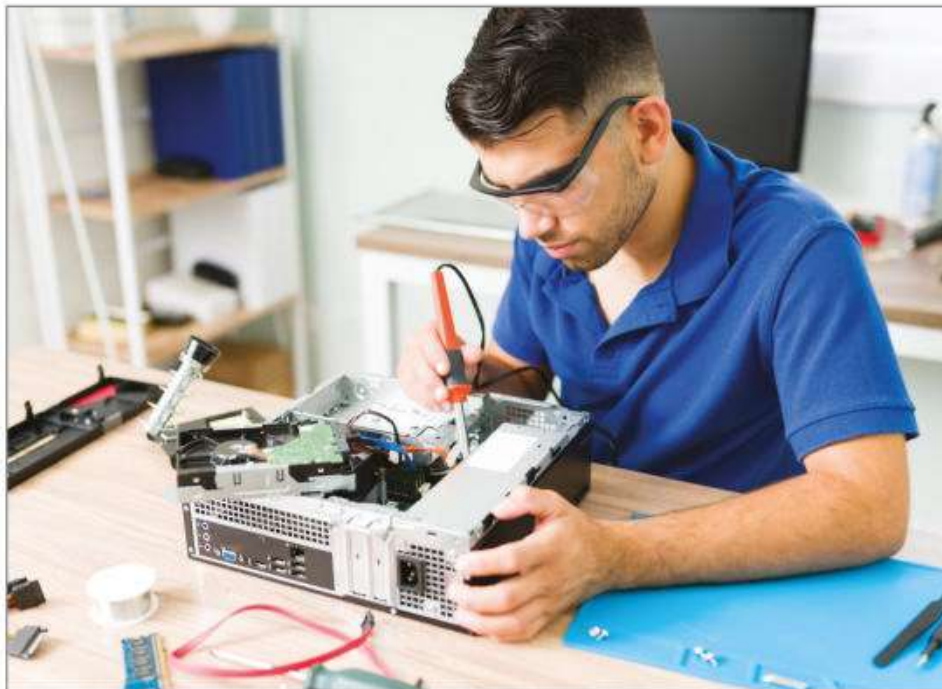
He's right. When you listen to someone saying that their machine's slow because they think it has a virus, then ask questions. Why do you think it's a virus? How old is the computer? You're using your expertise to ask questions that augment the customer's information. Questions fill the gaps in the narrative, which often appear when people who need help are unable to convey why.

Ultimately, asking and listening enables you to gather maximum information to streamline the workflow and repair the machine as quickly as possible. Ask, then listen and repeat as often as required.

6 Be thorough – Jon Honeyball

Every system is as weak as its weakest component. That means networking, systems processes, data archiving, backup, systems security and every other component.

Getting all of this to work requires a rare skill – expanding your view of the problem until every component is simple. Everything has a place, and there is a place for everything. There must be clarity, and that comes from a truly heroic level of detail understanding. You cannot treat any component of your process as an anonymous black box that will keep working provided you do enough hand waving.



ABOVE Fixing any sort of problem is impossible without listening to the user

A good example is networking. Have you considered every single component in the chain between your computer and the desired end point, whether that's an internal server, a cloud service or a website that runs your businesses processes?

Do you understand how each link contributes its own speed, risk and cost profile to the totality, and that any single component that fails

might cause the entire process to fail?

Being thorough means being totally honest with yourself, and correctly weighing up the risks and the remediation profiles.

How many businesses do you know where they claim to be fault tolerant, but will get extremely nervous if you say you want to test this in the middle of the working day? Does that show they really understand the processes and risk in a truly thorough way, or that there's far too much hope and assumption going on?

Being thorough means knowing all of this and seeing the big picture. In huge organisations, it isn't possible for one person to do this role. So have you put in place the processes by which teams can build this, in a way that they are trustworthy of everything else that goes on around them? Worse still, is there a culture of

BELOW Outdated hardware can lead to increased stress levels



"it's not my area, we cannot criticise another internal team", which is the absolutely guarantor that something will go badly wrong and there won't be the resilience to recover quickly?

Because things will go wrong, and always at the most inopportune moment. Disaster recovery and systems failure analysis is not something for a dusty binder that's checked every five years. It should be a living piece of your culture, whether you're a five-seat or 5,000-seat organisation. And bake it into every conversation and decision-making event. Because if you don't, your lack of thoroughness will come back to haunt you.

7 Understand the real costs of outdated IT – Barry Collins

I see this one all too frequently at home. My other half, a teacher, brings home a school-issue laptop to finish the several hours of out-of-school work she has to do every week.

The laptop takes an age to boot up, let alone do anything useful. She spends the next half an hour furiously trying to connect to the VPN, because the school (understandably) has to ensure pupil data isn't leaked. Everything takes at least twice as long as it would do with decent hardware, and the already 12-storey-high stress levels go up another couple of floors.

I wonder how many days of stress-induced leave the school suffers each year as a consequence of overloaded teachers battling inadequate equipment? I would wager the price of a new Dell XPS 13 that it far outweighs the cost of supplying decent hardware.

Of course, school IT budgets don't work like that, and nor do they in most companies. The board will allocate a fixed sum for IT for the year ahead, and whoever's in charge of the budget does their best with it. But only by understanding the true cost of inadequate IT can you try to influence spending decisions.

On a more low-key level, the same applies for the self-employed. Yes, you might not need a Honeyball-spec MacBook Pro to tear through your day job, but the pandemic proved what a strong investment decent, reliable computers and a high-quality screen are for home workers. I know there's a touch of Mandy Rice-Davies about this in a magazine that partly relies on advertisers flogging new kit, but the payback from investment in high-quality hardware is almost always worth it. ●



GIGABIT INTERNET

Get the speeds
you're paying for

Is your premium internet service not racing along like it should?
Darien Graham-Smith goes in search of faster downloads on every device

Home broadband is getting faster and faster. Many ISPs are now offering gigabit home internet connections in urban areas, and some go even faster.

Community Fibre has one package that goes all the way up to 3Gbits/sec (communityfibre.co.uk). We've come a long way since 56Kbits/sec dial-up.

But while the idea of an ultra-fast internet connection is appealing, once you've had the service installed you may find you're not getting the speeds you expect. That's probably because the infrastructure inside your home isn't fast enough to let your devices get the full bandwidth of your internet line. On these pages we'll find out why – and what you can do about it.

The woe of Wi-Fi

When you order a gigabit-class internet service, you can be fairly confident the line will run at the advertised speed as far as your router. But if you connect a client device to that router via Wi-Fi, you'll probably see much slower download speeds than the advertised headline rate. The simple fact is that not many Wi-Fi setups are fast enough to handle gigabit connections.

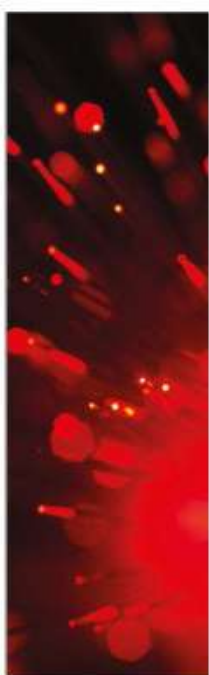
Now hold on, you might say: my wireless router should be way faster than my internet service. And it's true that almost all modern routers are advertised as supporting multi-gigabit speeds. The A-Listed Netgear Nighthawk RAXE300 (see issue 341, p68) goes as high as 7.8Gbits/sec.

Unfortunately, these ratings are misleading. For one thing, they refer to total bandwidth across the 2.4GHz and 5GHz radio bands, plus the 6GHz band in the case of Wi-Fi 6E and Wi-Fi 7 routers. Your devices, however, will connect on only one of these frequencies, so only a portion of that bandwidth will be available to them.

What's more, these bandwidth figures assume perfect radio transmission with no interference, but in the real world you can be certain that interference from nearby electrical appliances and other networks will affect performance. Wi-Fi signals also drop off rapidly with distance, so unless you're in the same room as the router, you can't expect your actual download speeds to bear any relation to the headline numbers printed on the router box.

Location, location

While you'll never see the advertised speed from a wireless router, there are things you can do to optimise performance. One of the easiest and most effective ways to minimise interference and signal fade is to situate your router as close as possible to where you use your wireless clients.



The simple fact is that not many Wi-Fi setups are fast enough to handle gigabit connections

Bear in mind, too, that your access point needs a fast Wi-Fi radio, or it may turn out to be slower than connecting directly to the router.

You could also consider replacing your router with a dedicated mesh system. Again, though, you don't want station-to-station communications to reduce the capacity available for client traffic, so look for a tri-band or quad-band system with a dedicated backhaul radio, or connect the stations together with an Ethernet cable.

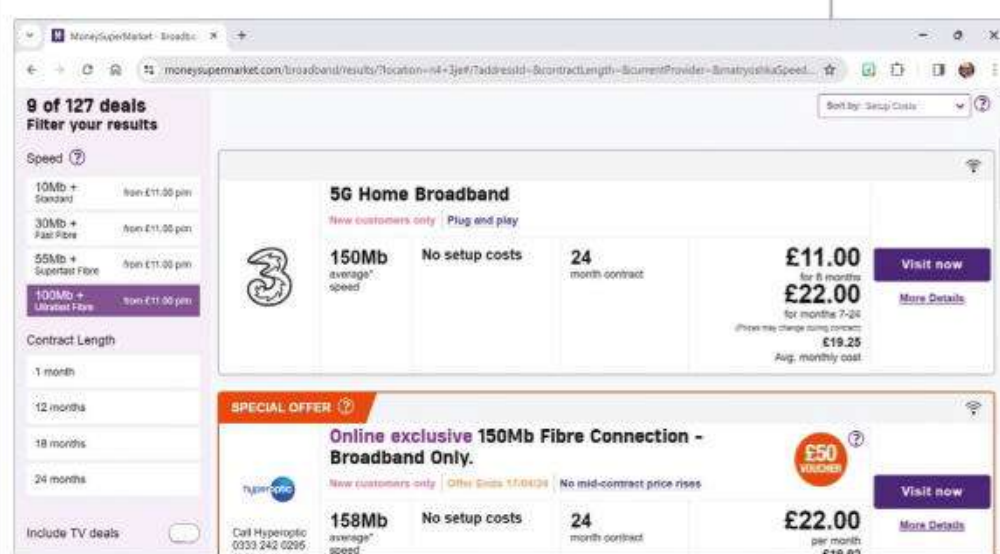
Standards and practices

Since the introduction of Wi-Fi in 1999, the technology has seen a series of major updates. Most routers and laptops now use Wi-Fi 6 and 6E (introduced in 2019 and 2021 respectively), and we're starting to see a trickle of Wi-Fi 7 gear.

Normally, this isn't something you need to think about too much. All Wi-Fi connections are backwards-compatible, so you can connect to a Wi-Fi 6 router from a Wi-Fi 5 laptop, or vice versa. But if you want to

make the most of a gigabit internet connection, you need a fast, modern connection. In practice that means Wi-Fi 6 or better; on paper, Wi-Fi 5 might look fast enough, but in the real world we've never obtained download speeds close to a gigabit from a consumer Wi-Fi 5 router.

Most ISPs will provide a Wi-Fi 6 router with their gigabit services, but not all, so it's worth checking which model yours comes with. Even if the



If need be, you can use a long Ethernet cable to move it into a different room to your wall box or modem.

Alternatively, you could leave the router where it is and install a second access point to get a good signal in two locations. If you're taking this route, we strongly recommend connecting the remote access point to the router via an Ethernet cable – if you use a wireless link, it will eat into the bandwidth available for your devices.

ABOVE Plenty of ISPs are now offering gigabit internet packages

Wi-Fi 7 to the rescue?

For most of its existence, Wi-Fi has been fast enough to easily keep pace with consumer internet services, but broadband speeds have recently been shooting up, and the latest Wi-Fi 6 and 6E routers can struggle to deliver the full performance of your internet line.

Things are looking up. We've already tested the first Wi-Fi 7 router and mesh systems – including the Netgear Nighthawk RS700S (pictured right; see issue 353, p76), the Amazon Eero Max 7 (see issue 352, p68) and, this month, the Netgear Orbi 970 (see p62). All three promise multi-gigabit wireless for compatible client devices, and they also both come with 10Gbits/sec Ethernet for ultra-fast wired networking.

If that sounds good, though, be warned that the Nighthawk costs £700, while the Amazon Eero is £975 for two mesh stations. What's more, we've yet to see any Wi-Fi 7-compatible laptops. They're expected to arrive later this year.

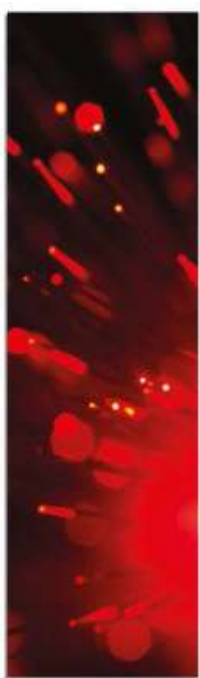
For now we recommend you hold fire on Wi-Fi 7. Even if your current router can't fully handle a gigabit internet connection, upgrading now will be very expensive, and won't immediately get you the benefit of the latest wireless technology. In the meantime, you can probably get along without gigabit speeds anyway (see "Who needs a gigabit?" on p41).





supplied router does support Wi-Fi 6, performance can vary hugely between models. You may be able to gain a big speed boost by replacing your ISP router with a third-party one.

The same principle applies on the device side of the connection. In Windows you can open the Device Manager and look under “Network Adapters” to find the model number of your installed wireless chipset; a quick web search will reveal whether it supports Wi-Fi 6 and at what speeds. On some computers you can upgrade your Wi-Fi hardware by fitting a PCI-E card into a desktop, or opening up the laptop case and replacing the installed M.2 network card with a superior model. If the

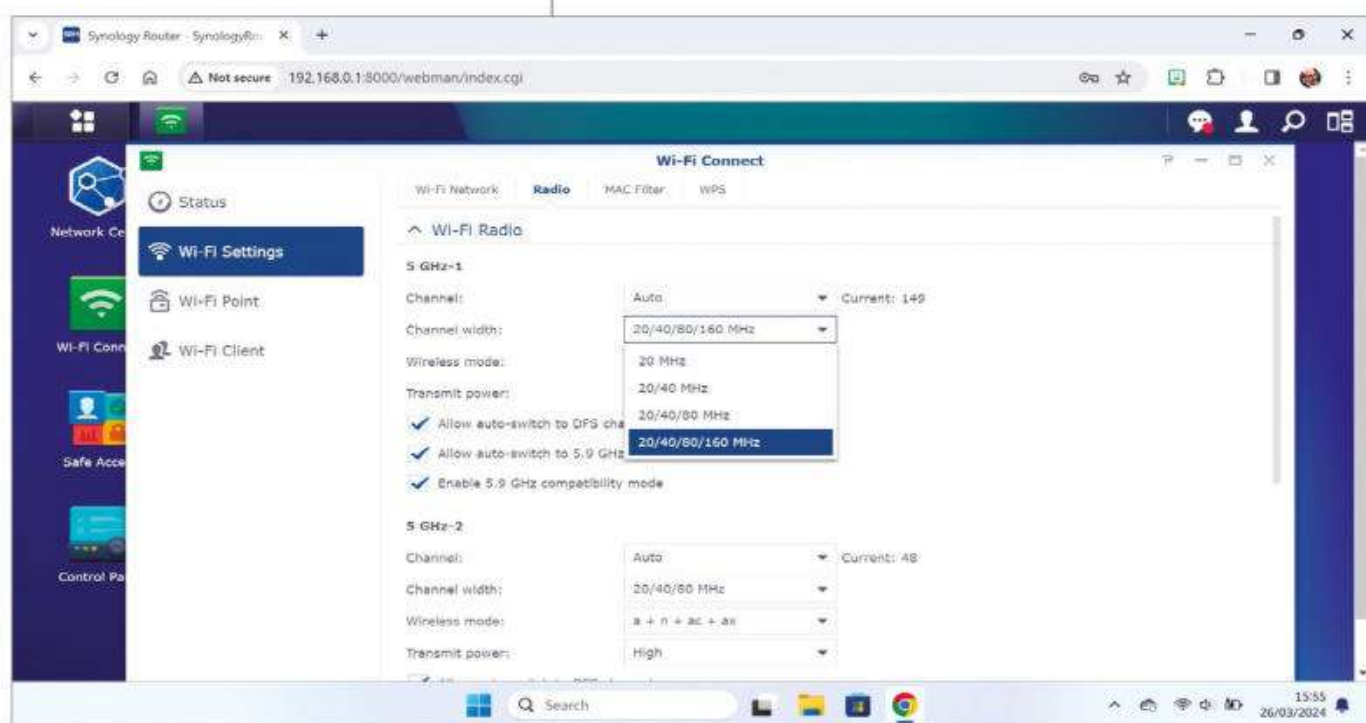


You can't beat Wi-Fi for convenience, but for the best possible speed and reliability, Ethernet is still the way to go

connections to the router and transfer data at twice the speed. Most consumer devices are capable of 2×2 MIMO – that is, two download connections and two upload connections – but this isn't always enabled on both the router and the client. Turning it on can be a very quick and easy way to double your download speeds. If your connecting device doesn't have MIMO then it's worth exploring whether you can replace its network card.

Wires still worthwhile

You can't beat Wi-Fi for convenience, but for the best possible speed and reliability, old-fashioned Ethernet is still the way to go. A ten-metre cable costs less than a tenner, and will



Wi-Fi chipset is integrated onto the motherboard, you can use a USB Wi-Fi adaptor, but these rarely perform as well as an internal card, owing to their limited antenna size. Your other alternatives are to use a wired connection (see below) – or to treat yourself to a new laptop.

Setting the scene

Even once you've got a solid Wi-Fi 6 connection running between your device and router, you may still not be seeing the full speed of your internet connection. All is not lost: you can often improve wireless performance by tweaking some settings.

One Wi-Fi optimisation that's often recommended is finding the best radio channel for your network. Some routers do this automatically; if yours doesn't, there are plenty of free smartphone apps that can measure Wi-Fi signal strength in different parts of your home and show you which channels are being

used by nearby networks, so you can configure your router to avoid them.

Switching channels can gain you some performance, but what makes a much bigger difference is using the widest channel you can. Wi-Fi 5 and some Wi-Fi 6 routers default to an 80MHz channel, but if possible you should certainly enable the maximum 160MHz option. This allows the router and client to send and receive data across eight standard Wi-Fi channels at once, conveying a huge number of bits per second. It also reduces the relative impact of interference, because only certain frequencies within the signal will be affected.

Another important setting to check is MIMO, short for “multiple in, multiple out”. Similar to channel bonding, this allows a single device to open two or more simultaneous

ABOVE Tweaking your router's settings can boost Wi-Fi performance

ABOVE RIGHT It's easy to check your internet speeds online or via an app

BELOW You won't get the advertised 7.8Gbits/sec from Netgear's Nighthawk RAXE300



normally be far faster than a wireless connection over the same distance.

Ethernet does have its drawbacks. For one thing, most routers only have four Ethernet ports, which puts a limit on the number of wired clients you can plug in. If you need more, you can use an external switch to connect multiple devices to a single socket on your router – but remember that, since they're all sharing a single Ethernet connection, they won't be able to all get full-speed uploads and downloads at the same time.

Ethernet is also harder to physically install than a wireless connection. Technically speaking, Ethernet cables can run over distances of up to 100m, but you may need to engage in some light DIY to get connections in the rooms where you want them. Even then, wired networking works best for desktop PCs and laptop docking stations, rather than pocketable mobile devices.

Who needs a gigabit?

If you're considering signing up for a gigabit internet connection, it's worth asking yourself what precisely you expect to do with it. In future, it's predicted that such services will power immersive real-time AR and VR experiences, but today there aren't many applications that benefit from these sorts of enormous speeds. For your usage there may be no downside to sticking with a cheaper mid-range broadband package, at least for the foreseeable future.

What won't benefit

Web browsing, shopping and social media A fast connection can help web pages and search results appear more quickly, but once you get past 100Mbps/sec, any additional speed won't normally make any noticeable difference. If your content doesn't appear right away, that's likely down to how long it takes the server to generate your content and your device to render it, rather than transfer speed. **Video streaming** For 4K HDR video streaming, Disney+ recommends an internet speed of 25Mbps/sec. As long as you're above that baseline, a faster line won't make any difference to your viewing experience, even if you have several family members all wanting to watch at once in different rooms.

What might benefit

Downloading apps and games With a gigabit connection you can theoretically download files at speeds of over 100MB/second, but not all third-party servers will send you items at that speed. On Windows and the Xbox we're accustomed to seeing downloads top out at around 60MB/sec over a gigabit line, which is no faster than you'd get from a broadband connection running at half the speed. **Cloud syncing and backup** If you work with remote files then a faster internet connection can help big documents zip promptly down the line. Again, though, everything depends on the server at the other end: I tried accessing a 10GB file on Google Drive and had to wait over three minutes for it to download over my gigabit line – an effective download speed of around 440Mbps/sec. Some ISPs' services are asymmetrical, so your own changes and backups will be slower to upload. **Online gaming** A faster connection can help load levels more quickly, and even get you into the game ahead of your opponents. But if that's your priority then gigabit internet is overkill: even if you're streaming the whole game, it shouldn't need any more bandwidth than a 4K video. In fact, for gaming, latency (response speed) is more important than overall bandwidth; check the ISPs available in your area to find which can give you the slickest gaming experience.

What will benefit

Remote work When you're accessing company servers, a gigabit line should help everything feel snappy and responsive, especially if you're accessing a remote desktop. Again, though, latency comes into play, and you'll get a good experience only if the company has made the necessary investment in its own infrastructure. **File sharing** We're not suggesting that file sharing is the best use of a gigabit internet line, but if that's what you're into it's a highly attractive prospect. BitTorrent clients can concurrently download different segments of a file from different locations, so you can connect to ten or 20 seeders at once and completely saturate your internet pipe with incoming data.



ABOVE The number of Ethernet ports on your router is a big limitation

As with Wi-Fi, there are several different Ethernet standards. Again, they're all cross-compatible, but when you mix and match ports and cables you'll be limited to the speed of the slowest component. If one of your devices is using the old 100Mbps/sec Ethernet standard, that will really drag down your performance.

Thankfully, almost all modern wired networks use gigabit Ethernet. As the name implies, this is a good choice for a gigabit internet

When you mix and match ports and cables you'll be limited to the speed of the slowest component



ABOVE A new Wi-Fi card can be a cheap way to boost your internet speeds

connection, though in practice it won't let you download a full gigabit per second of data. This is because the Ethernet protocol uses some bits for processing and encoding, leaving an effective 928Mbps/sec of bandwidth for your data. While that's quick, it means you can't quite max out a gigabit internet line, and it certainly won't do for faster connections.

If that's what you want, the answer could well be 2.5Gbps/sec Ethernet. This newer standard provides a big uplift in performance over gigabit Ethernet, while using the same cables and physical connectors. It's a cheap upgrade on the computer side – a 2.5GbE USB adaptor can be had online for less than £25 – but if your router doesn't have any 2.5GbE-compatible ports, your only recourse is to replace it with one that does. Remember that if your router is connected to a separate modem or wall box then you'll also need a multi-gigabit connection between those two components – otherwise, the router's own internet connection will be limited to gigabit Ethernet speeds. ●





TURN YOUR DUMB TV INTO A SMART ONE WITH A RASPBERRY PI

*Enjoy video on demand and more –
Nik Rawlinson finds out how the humble Pi can transform your TV*

Old TVs are cheap to replace, even if you're buying something larger or smarter. But disposing of a spare display is wasteful. It could be given a second life in a kitchen or bedroom – and, while you can't make your old TV any bigger, you can make it a lot smarter, quite easily and cheaply.

As you'll have gathered from the title, the secret ingredient is the Raspberry Pi. One option is to attach the Pi directly to your TV, something that's gloriously easy to do thanks to the Pi's integrated HDMI. But for an even better experience you can set up your Raspberry Pi as a network server, and use it in combination with a streaming device such as the Amazon Fire TV Stick 4K, Chromecast or the Roku Express HD Streaming Media Player, to browse and play your own media library.

Going this way doesn't add much to the cost – the various streaming stick models all start at around £35. They can plug directly into a spare HDMI port on the back of the TV, so they're very neat (the only other cable required is a USB connection

for power), and they come with convenient bundled remote controls, allowing easy access to the stick's native apps, plus your own media and other content served up by the Pi.

SPEC UP YOUR RASPBERRY PI

If you have any sort of Raspberry Pi sitting idle, you can probably use it for this project. We're going to use the DietPi OS, which is light enough to work well on older boards such as the Raspberry Pi 3, and you don't need any additional hardware on the Pi side, beyond the usual power supply and microSD card.

However, we do recommend you find or buy an external USB hard disk for your media. You can store video files on the internal microSD card, but space is likely to be more limited,

and if you make heavy use of it you could shorten its working life.

INSTALL DIETPI

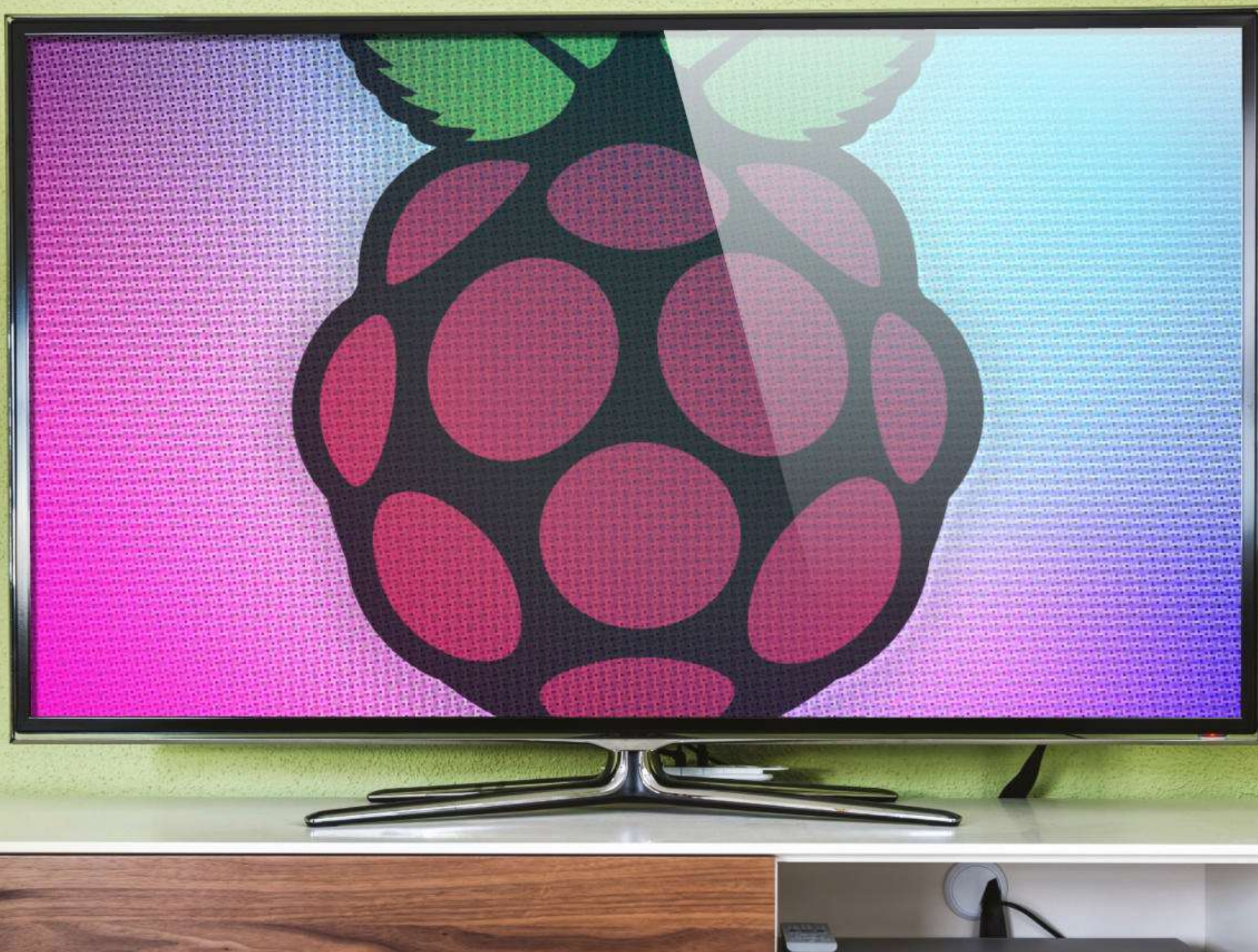
While there's nothing wrong with the standard Raspberry Pi OS, DietPi is a better fit for this job because it comes bundled with installers for all the third-party software that we'll use for this project – plus plenty of other media-friendly tools you can try out. You can download it for free from dietpi.org, and you'll also need an imaging tool to write it to your microSD card. One such tool we like is Balena Etcher (etcher.balena.io), which runs on Windows, macOS and Linux, and lets you fully prepare your card so the Pi can boot directly from it.

If you plan to connect the Raspberry Pi to your router via Ethernet, then you can boot it up from your microSD card as soon as you've imaged it. However, if you want the Pi to connect via Wi-Fi then you can save yourself some bother by configuring this on your PC before moving the card over to the Pi.

To do this, open up the microSD card in the Windows File Explorer,

BELOW Use an imager such as Etcher to write the DietPi OS to your microSD card





find the file `dietpi.txt` and edit it using Windows Notepad (or any plain text editor). Then press `Ctrl-F` and search for `AUTO_SETUP_NET_WIFI_ENABLED`. Set the value beside this to 1.

Save and close the file, then open `dietpi-wifi.txt`. Search for `aWIFI_SSID[o]` and set its value to the name of your wireless network; then search for `aWIFI_KEY[o]` and set its value to your wireless network's login password. Once you've saved the file, DietPi will be configured to connect to your wireless network automatically at startup.

Now you can eject the card from your PC, insert it into your Raspberry Pi and boot up the system. Once it's up and running, you can connect to it via SSH from your PC: to do this you'll just need to find out its IP address. This should be easy to do from your router's management console; on our network it's 10.0.0.88. To connect, open a Command Prompt on Windows and enter:

```
Open  dietpi.txt
# IMPORTANT:
# - This is intended for advanced users, unless you
#   know what you are doing, do not edit this file.
#   Please use the DietPi programs instead.
# - Do not remove uncommented lines, as the items
#   are scraped by DietPi programs, on demand.

##### DietPi-Automation settings, applied on first
boot of DietPi only, ONCE! #####

##### Language/Regional options #####
# Locale e.g.: "en_GB.UTF-8" / "de_DE.UTF-8" | One
# entry and UTF-8 ONLY!
AUTO_SETUP_LOCALE=C.UTF-8

# Keyboard layout e.g.: "gb" / "us" / "de" / "fr"
AUTO_SETUP_KEYBOARD_LAYOUT=gb

# Time zone e.g.: "Europe/London" / "America/
# New_York" | Full list: https://en.wikipedia.org/
# wiki/List_of_tz_database_time_zones
AUTO_SETUP_TIMEZONE=Europe/London

##### Network options #####
# Enable Ethernet or WiFi adapter: 1=enable |
# 0=disable
# - If both Ethernet and WiFi are enabled, WiFi will
#   take priority and Ethernet will be disabled.
# - If using WiFi, please edit dietpi-wifi.txt to
#   pre-enter credentials.
AUTO_SETUP_NET_ETHERNET_ENABLED=1
AUTO_SETUP_NET_WIFI_ENABLED=0
```

ABOVE Update the DietPi configuration with your Wi-Fi details

ssh root@10.0.0.88

After a moment, you'll be asked if you want to authorise the connection. Type "yes" and press Return; then, when asked for a password, type "dietpi" and press Return.

You'll now be logged in. DietPi will download any available updates, then apply the necessary first-run steps. It will ask if you want to change the global software password for applications that DietPi installs; this is highly recommended, as otherwise anyone with experience of the DietPi distribution would be easily able to gain unauthorised access. Use the cursor keys to select "Ok" and press Return.

Enter your preferred password twice, then repeat the process to change the login passwords for the "root" and "dietpi" users.

You'll next be asked if you want to turn off serial/UART console. Select Yes and press Return.

This will bring you finally to the DietPi-Software installation screen.

We'll come back to this a little later; for now, just navigate down to "Install" at the bottom of the screen and press Return. You'll be asked if you want to continue setting up a pure minimal image; select "Ok" and press Return to complete the setup process.


As part of the last step it will ask if you're happy for DietPi to collect anonymous usage statistics. The default is to opt out, but choose whichever you prefer.

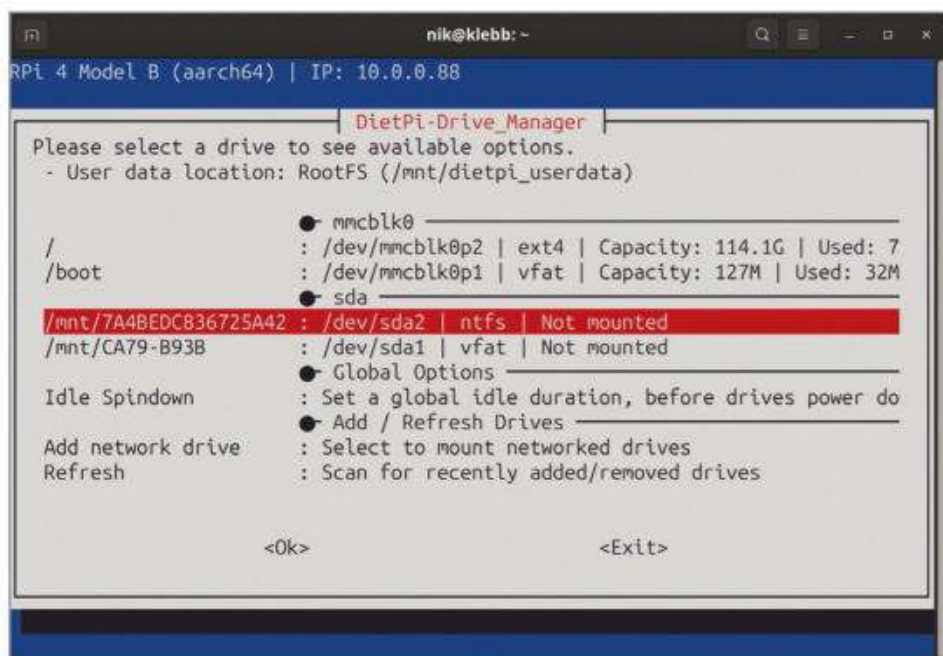
You'll now be looking at the DietPi command prompt, which will display a little information about your system, including the board type and temperature. Don't worry if it says it's "Running warm, but safe": this is quite normal for a board without active cooling.

MOVE YOUR USER DATA

If you've attached an external hard drive for your data, now's the time to configure it. At the DietPi command prompt, enter:

sudo dietpi-software

In the interface that opens, go down to "Drive: Launch DietPi-Drive_Manager" 



and press Return. When the interface appears, select the external drive from the list. Ignore the mount points “/” and “/boot”, as these relate to your SD card; the external drive appears in the sda section. In our case (see image, above) we can easily recognise it as the only NTFS drive attached to the system, and its specific identifier is /dev/sda2. Highlight your own drive and press Return, then select Format and press Return to see the formatting options.

This brings up a few options, all of which we can leave in their default state. Format Mode is set to partition, meaning it will wipe the entire drive, while Filesystem Type is set to ext4, which is the standard setting for Linux-based systems. The Format button is already selected, so just press Return to action it.

Once the drive has been formatted, highlight Back and press Return to go to the previous screen; then highlight your newly formatted drive, press Tab to select OK, and press Return.

You can now specify what the drive will be used for: key down to “User data” and press Return. Confirm that you want to move your user data from the existing location; once this operation has completed and you’ve returned to the previous screen, press Tab to select Back, then press Return. Tab across to Exit and press Return again to go back to the DietPi-Software home page.

INSTALL THE FILE MANAGER

The next step is to move your media files onto the external drive; to help with this, let’s install a browser-based file manager tool. On the DietPi-Software home page, key up to Browse Software and press Return. This opens a lengthy catalogue of preconfigured application installers; key down to “198 File Browser: web-based file manager”, which you’ll find in the “Cloud & Backup” section. Press Space to select it (an asterisk appears

ABOVE LEFT We know this is our external drive as it’s NTFS formatted

ABOVE RIGHT Select option 198 to install the File Browser

BELOW Ensure you use the userdata folder on your external hard drive

between the square brackets next to its name). If you want you can use the same method to select additional apps to install from the list; once you’re happy with your selection, press Tab to select Confirm and hit Return.

You’ll now arrive back at the DietPi-Software home page. Key down to Install and press Return to install the file browser (and anything else you’ve selected).

Once the installation is finished, open a web browser on a remote computer (not on the Raspberry Pi itself), and enter the IP address of your Raspberry Pi, followed by “:8084” – so in our case, that would be “10.0.0.88:8084”. You’ll be prompted to log in; enter the username “dietpi” and whatever password you specified earlier.

You should now see an interface similar to the screenshot below. You’ll see a promising-looking folder called dietpi_userdata, but if you’ve set up an external hard drive you should ignore this – it’s the old user data folder that you’re no longer using. Instead, click into your mounted hard drive, and then navigate into the dietpi_userdata folder located on that volume. In the screenshot, our drive is represented by the long hexadecimal string at the top of the folder list.

Inside your dietpi_userdata folder, you’ll find subfolders for Music, Pictures and Video. Upload your media files to the appropriate locations; when you’ve finished, you can close the browser and return to the DietPi prompt in your command window.

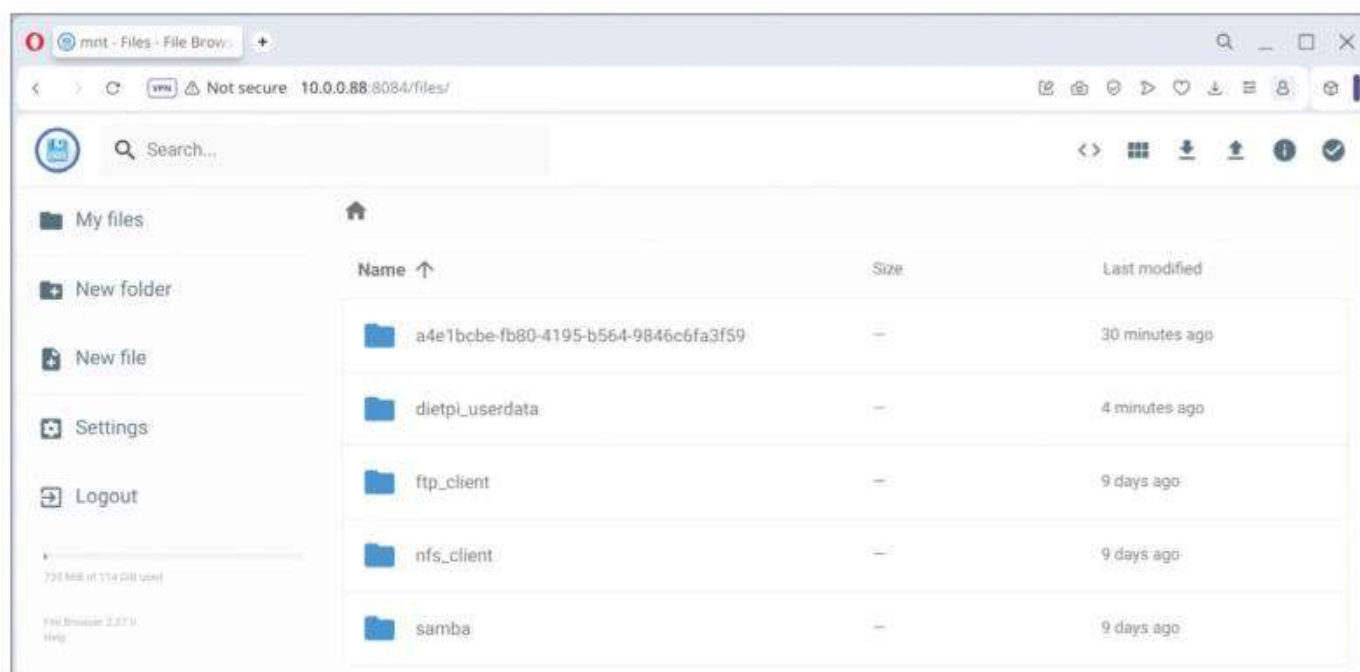
INSTALL YOUR MEDIA APPS

You can now return to the software installer by entering:

sudo dietpi-software

Key down to “Browse Software” and press Return. Now, select either “31 Kodi” if you’re going to attach your Raspberry Pi directly to your TV, or “178 Jellyfin” if you’re going to run it headless and access your media via a streaming stick. In either case, press the Space bar to place an asterisk beside your selection, then press Tab to highlight Confirm, followed by Return. Finally, key down to Install and press Return to add the selected packages to your DietPi system.

As part of the setup process, you might be asked if you want to set some programs to start when your Raspberry Pi boots. Navigate to “Ok”, then key down to the app you want to



RIGHT You can download Jellyfin clients from the major app stores

launch at boot. Don't worry if you're setting up Jellyfin and you don't see this option: it's a background service that runs automatically.

SETUP JELLYFIN

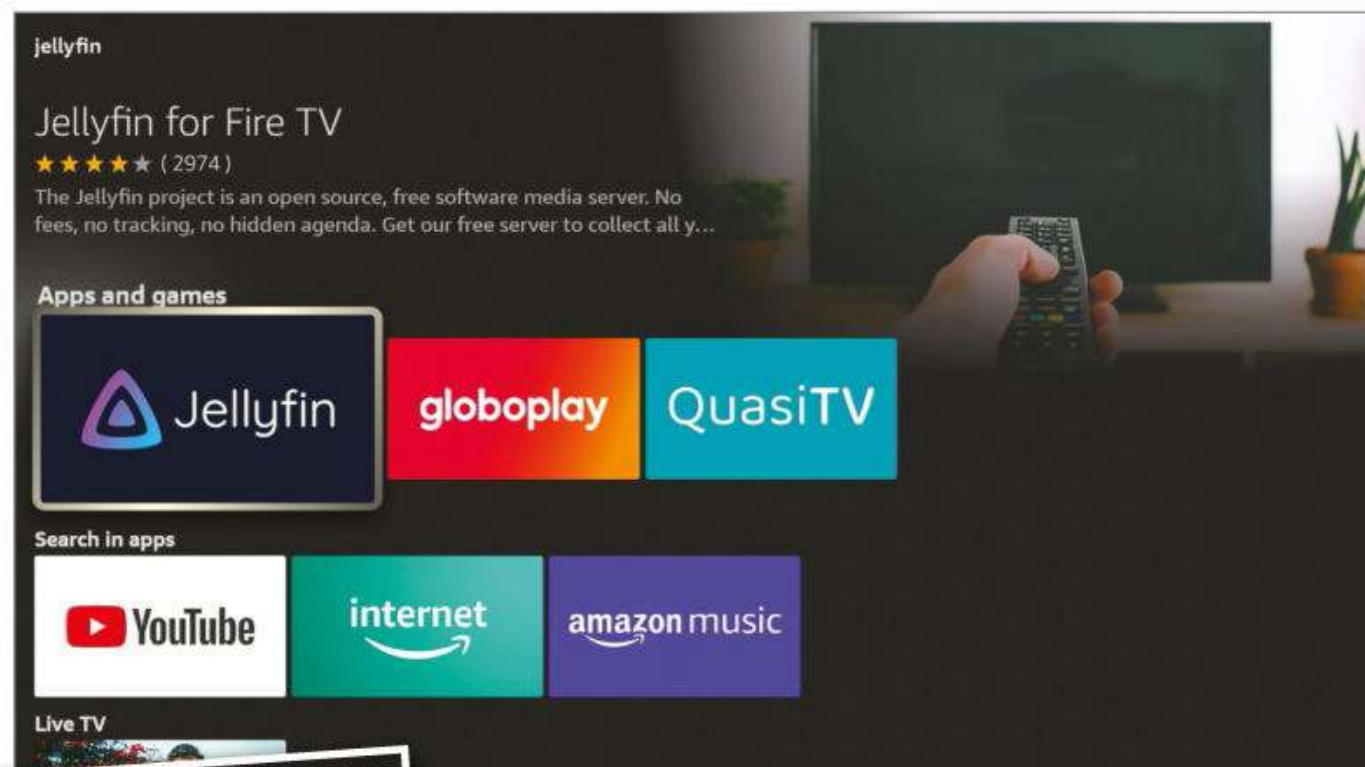
Jellyfin runs as a server, and exposes a web interface on port 8097. You can therefore access it by opening a browser on any PC on your network and entering your Pi's IP address followed by a colon and the relevant port number. In our case, this would be 10.0.0.88:8097.

The first time you visit it, you'll be prompted to work your way through the installation wizard, creating a user account and optionally setting a password. When you get to the page entitled "Set up your media libraries", click "Add Media Library". Select the type of content you're adding from the dropdown menu, then click the "+" beside Folders.

You now need to point Jellyfin to the folder where you placed your video files; click into the drive prefixed "/mnt/", then "dietpi_userdata" and finally "Video". Now click "OK" twice. Optionally, repeat this process for other media types you want to add, such as music.

Click your way through the remainder of the wizard, then sign in using your username and (if you set one) the password you just specified.

Once you've completed the initial setup, you can use Jellyfin's web interface to play video directly in the browser. However, we want to play our media on the TV, so we'll also set up a streaming stick to receive media from the Pi. This is



ABOVE The Jellyfin app links to the server running on your Raspberry Pi

BELOW Enabling Jellyfin's DLNA features will make it easier to set up in the TV app

easily accomplished using the Jellyfin app for Chromecast or Fire TV. Depending on which device you're using, you can download it from the relevant app store.

To simplify setting up your clients, click the three lines at the top of the Jellyfin interface in your browser, followed by Dashboard. Here, tick the boxes beside both "Enable 'Play To' DLNA feature" and "Enable DLNA server".

Once you have the Jellyfin app installed on your streaming stick, start it up. It should immediately start looking for a Jellyfin server on your local network – and since you've enabled DLNA it should find it automatically. If not, manually enter the IP address and port; highlight the selected server using your streaming stick remote, then press the Select button to connect to it.


Now click "Add account" and Jellyfin will display a six-digit code. Return to Jellyfin in your browser and click the person icon at the top right corner of the screen, followed by "Quick Connect". Type in the code from your TV and click "Authorise" to link the app to your Jellyfin account. This will log you in on the streaming stick, after which you can navigate your hosted media using the stick's remote control.

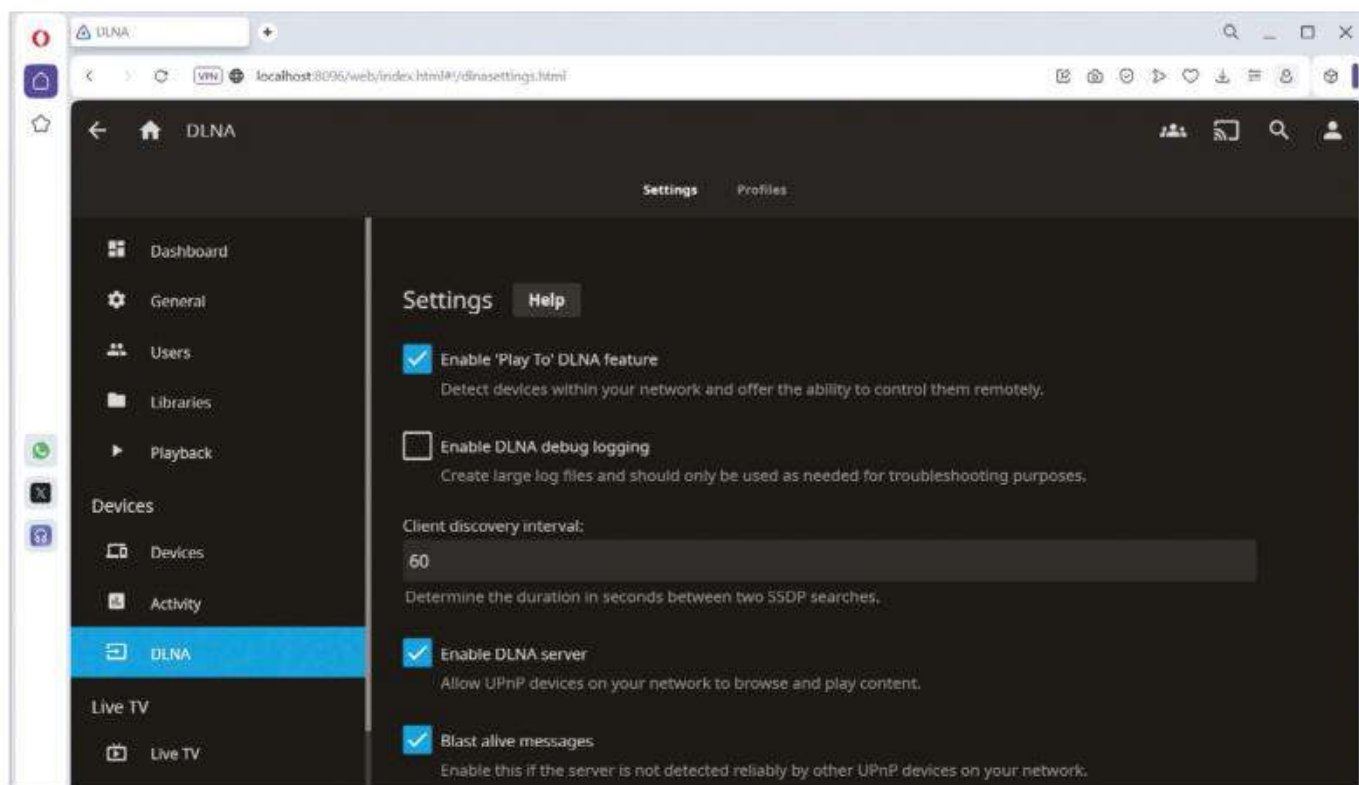
SETUP KODI

If you're connecting your Pi directly to your TV you don't need to use a server like Jellyfin – you can use the local Kodi app. As you'll recall from above, we've already set this to start on boot; switch your TV to the channel to which your Raspberry Pi is connected and you should see it already running. If it isn't, reboot your Raspberry Pi.

There are lots of ways to control Kodi. Depending on your model of TV, you might be able to use its own remote to navigate the Kodi interface. Alternatively, there's a wide range of Bluetooth remote controls (including console controllers) that can be used, or you can simply plug in a keyboard and mouse.

Whichever control option you choose, you can browse your media by selecting Videos (near the bottom of the sidebar), then clicking Files in the main part of the window and navigating to your Videos folder. From here you can select and play items on your TV.

Kodi can do more than just play local media, too: various plug-ins can be used to stream content from online broadcasters, including YouTube, the way you might with a traditional smart TV. You'll find a wide selection of extensions by clicking "Add-ons" in the sidebar, followed by "Enter add-on browser" in the main part of the window. 





Brilliant business comms at zero cost

Whether you choose 3CX Free or 3CX SMB V20, it's time to say goodbye to per-user pricing and bundle rip-offs

They're two of the most dangerous words in the English language: "per user". See them next to a software licensing price and watch your monthly costs rocket, and it's as true for communications solutions as it is for every other service you pay for. If not worse, with dangerous hidden T&Cs designed to make it tricky to escape a contract's clutches.

3CX has the answer in the form of the all-new 3CX V20. As you've become used to with 3CX, the service is free forever for up to ten users. And that includes all the features highlighted below.

In short, where others are charging \$20 per user per month for their communications platforms, 3CX is offering you a full service for free. And where others tie you into long-term

contracts with phone numbers owned by the platform, making it hard for you to move away, 3CX keeps things simple. You own the numbers, you decide the calling package.

And if you want to take advantage of 3CX's most advanced contact centre features, 3CX SMB costs just £195 for a year. No contracts, no hidden extras and no gotchas either.

■ What's new in V20

There's never been a better time to start using 3CX, as it has just been upgraded to version 20. More than two years in the making, 3CX V20 includes a rewritten Call Manager to deliver the best call centre features; a new native Windows softphone (more on that below); plus a new Admin Console, replacing the former Management Console.

3CX has enhanced security in this release, too. It has completely rebuilt the network to be both hardened and isolated, making it as secure against attacks as possible, and backed that up with new EDR monitoring tools and off-site 24/7 monitoring staffed by threat-hunting specialists. And it has enhanced the product security features with password hashing, locking down the web client by IP address and enforcing 2FA where Google's single sign on architecture isn't already in place.

Then there's the new native 3CX Windows softphone, which adds extra security as it's deployed via the Windows store. Like the existing iOS and Android apps, you can run it in conjunction with the web client and, rather than a simple call notification, it comes with a proper answer dialog. As a native softphone it also allows for audio control to be independent from the browser.



LEFT The new 3CX Windows softphone adds extra security



■ What you get for free, forever

Whether you choose the 3CX Free service or the paid-for 3CX SMB V20 package, everything a small business needs for a comms system is there. That includes full integration with WhatsApp and Facebook Messenger, plus Live Chat – that is, 3CX's WordPress integration to help site visitors.

You even get unlimited videoconferencing on top of free calls. That means the only fee you need to pay is for the external numbers you buy. See our box, "Choosing the right SIP trunk", for more details on this.

You also enjoy full use of the web client, the new Windows softphone, plus the iOS and Android apps.

As per 3CX's long-standing promise, this is free, forever, and your licence covers up to ten users.

■ Advanced features

As stated right at the top of this article, 3CX doesn't want people to fall into the trap of long-term contracts with per-user pricing.

ABOVE 3CX offers everything a small business needs for a comms system

That's why the advanced, paid-for version of 3CX SMB V20 costs a fixed yearly fee of £195 for up to ten users and £295 for up to 20 users.

So, what do you get for your money? The answer is a more managed product designed for more demanding users, such as multi-level interactive voice response (IVR). While the free version of 3CX does offer IVR, multi-level means you can direct callers to the sales or support departments (for example) rather than directly to one number.

You will also benefit from call queues, reporting tools and the "Barge in, Listen or Whisper" feature. This means a manager can monitor an agent's call, and intercede where necessary – such as "whispering" into the agent's ear, while the caller won't hear a thing.

And while the free version of 3CX includes up to three deskphones, 3CX SMB provides any number of deskphones and backs it up with support. You get SMS/MMS support, too.

■ Too good to be true?

The catch? There is no catch at all. 350,000 customers worldwide have used 3CX's service to make it the leading PBX VoIP provider in the global telephony market. In the same way WhatsApp revolutionised text messaging, 3CX wants to revolutionise business communications – and make it fair and freely available to all.

What's more, 3CX is always looking to the future. With V20, it has laid the foundations for deep integration of AI. Starting with call transcription and reporting, it has created the ability not just to transcribe calls but also analyse and report on them. It's a space to watch in the coming months.

And AI is just one example: this is a secure and expandable architecture designed for improvements. Join the 3CX forum and follow the company on your favourite social media platform to discover its ongoing plans – with Microsoft Teams integration, extra reporting capabilities, multi-tenancy and advanced mixing features during video conferencing just a few of 3CX's planned upgrades. ●

CHOOSING THE RIGHT SIP TRUNK

You need a SIP trunk to place calls to external numbers. You also need a SIP trunk to have a number on which your customers can call. To let you keep full control of your phone numbers and negotiate the best call rates, 3CX doesn't have built-in numbers. Instead, you have the freedom to choose any one of 3CX's supported SIP trunk providers.

You'll find a full list of providers – including 3CX's preferred choices of fuse2 and Gradwell – at [3cx.com/partners/sip-trunks/uk](https://www.3cx.com/partners/sip-trunks/uk). The 3CX team makes sure that all templates from listed SIP Trunk Providers are updated and tested with every release, which ensures smooth implementations and migrations for users.

Take a look and you'll discover how much cheaper it is to run a SIP channel than a traditional ISDN phone line – and how much lower the call charges are. Not only does 3CX offer you a state-of-the-art next-gen phone system, it also gives you an opportunity to save thousands per year on your telecoms charges.

Try 3CX FREE www.3cx.com/signup

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It's expensive and niche,
but this glasses-free 3D
monitor opens up a host of
exciting possibilities



Lenovo ThinkVision 27 3D

SCORE ★★★★★

PRICE **£2,250 (£2,700 inc VAT)** from
lenovo.com/uk (availability TBC)

I can't tell you my exact words when Lenovo's 3D software first kicked in because this is a family magazine, but suffice to say that they were accompanied by a cackle of delighted laughter. This was all the more surprising as I've seen glasses-free 3D in action many times, most recently on Acer's Predator Helios 3D 15 laptop (see issue 353, p56). Yet still I was taken aback: there, in front of me, on a 27in monitor, sat a 3D object.

You can read how the technology works on p92, so all I will say here is that an ingenious combination of lenticular lenses and eye-tracking technology allow the ThinkVision 27 3D to beam one set of images to your left eye and another to your right. There's also the small matter of a 3D engine inside the monitor that removes much (but not all) of the load from the host PC.

Other than running Lenovo's software, that's it. Sit in front of the monitor at a normal viewing distance

and it will work. It feels natural, and even when using it for 15 minutes at a time I didn't experience eye strain.

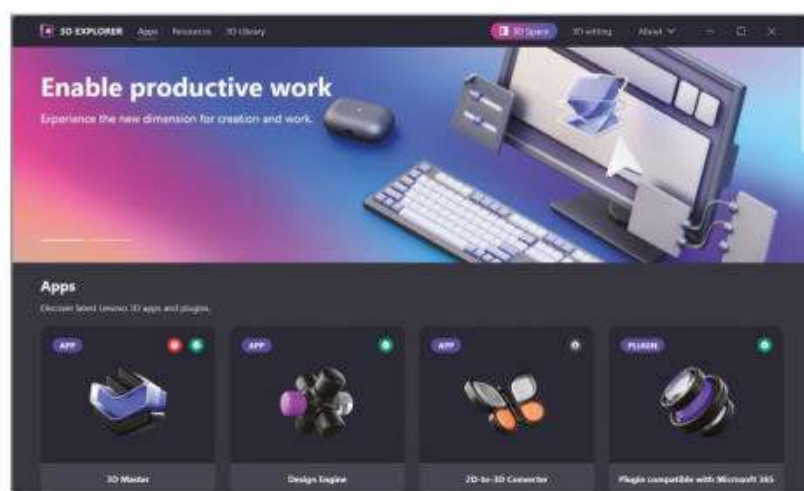
3D Explorer

I don't want to undersell the importance of Lenovo's 3D Explorer software. Developing this has been a lengthy process – the hardware has been ready for almost a year – and it's clear that Lenovo has worked hard to make it both attractive and intuitive.

You'll quickly find plugins for viewing 3D models in 3ds max, Creo and even Microsoft 365 (for example, viewing a 3D object in PowerPoint). Or you can open Lenovo's 3D Master app and open a supported file type

ABOVE The monitor
beams one set of
images to your left eye
and one to your right

BELOW Lenovo's 3D
Explorer software is
attractive and intuitive



directly. I found the Design Engine app particularly effective, as this creates a floating icon that you can press when in a modelling app (I used it with Sketchup) and it will then render the active model into 3D.

Results with other people's models are hit and miss. For example, when I rendered an Intel processor I could twist it any which way I wished, but when I tried to view a set of Budapest churches the software didn't allow me to zoom in. Then again, you have to be realistic: even though 27in is a good-sized area for 3D effects, it's not like working in virtual reality when you can look in any direction.

Real-time 3D

I achieved all this on a Surface Book 3 with a Core i7-1065G7, 16GB of RAM and elderly GeForce GTX 1650 graphics. That's possible because the main on-PC graphical work required is to render the model, so you merely have to wait for this to happen. When I tried to run the real-time 2D to 3D plugin, however, I was told my GPU wasn't supported. According to the manual, you need GTX 1050 graphics or above.

The app did work on the Asus Vivobook Pro 15 OLED (see p60), but I

wasn't taken by the effects. Likewise when gaming. Lenovo provides a Gaming Assistant applet, but I had zero success making it work on the Vivobook or my Surface. Acer's Helios 3D laptop uses a service called TrueGame that runs compatible games with exactly the right settings, and that mostly works well. Lenovo needs to provide something similar.

This brings me to one of the most important factors for anyone considering this monitor: the 3D features only work over a USB-C connection. Few desktop graphics cards offer this as an option, and it's highly unlikely that your existing desktop workstation does. I wish there was a way around this – using the USB-C input for data only, for example – but there isn't. And I have bad news for Mac users, too: it's currently only compatible with Windows 10 and 11. Time to buy a mobile workstation, perhaps.

■ Back to reality

Even if you work in 3D, most of the time you'll be using the ThinkVision 27 3D as a normal monitor – and it's excellent in this mode. With one tiny caveat: move close to the monitor and you can see what look like tiny dots on the display, and this lends whites a faint grey tinge from normal viewing distances. But I say "tiny" because it's only noticeable on white backgrounds, and once I started working on documents I forgot about it.

Similarly to Eizo's ColorEdge CG2700X (see p90), the ThinkVision ships with pre-calibrated profiles for all the major colour spaces: sRGB, DCI-P3, Adobe RGB, BT.709 and BT.2020. Switching to each will lock the panel down to those gamuts; for example, in DCI-P3 it covered 96% of the space out of a 98% volume, and in Adobe RGB it was 95% and 97%.

Colour accuracy is yet another strength. Its worst performance came in the sRGB colour space, where it had an average Delta E of 0.45 and a peak of 1.49. Aside from this, the visible colours were almost all under 1 and effectively perfect to the visible eye.

I wouldn't recommend this monitor to people wanting to edit HDR video, though, as its peak brightness is 322cd/m². Nor would it be my first port of call for watching films or playing games, with an unexceptional contrast ratio of 1,050:1 and a peak refresh rate of 60Hz. At least its response times are good,



with 4ms grey-to-grey if you use the Extreme overdrive setting.

■ OSD extras

You can access this and other settings either via Lenovo's Accessories and Display Manager software (assuming you're connected over USB-C) or the OSD. The latter uses a joystick at the rear right of the monitor, and while it's intuitive it's surprisingly sluggish for such an expensive monitor.

But there's good news. First is the dedicated button for switching between the four video inputs. Second is that you can allocate shortcuts to the joystick. For example, if you regularly jump between colour modes you can press right (for example) on the joystick to bring up the gamut options rather than going through the full menu.

The software offers far richer options than that menu, including automatically switching colour modes based on the app. So if you know you always want InDesign to run in Adobe RGB

but you want 3D Explorer to stick to sRGB, you can control it. Not all your software will be detected, though; for instance, there was no sign of Sketchup. And although there's one user preset, your colour options are minimal. Again, the Eizo wins here.

■ Bezel extras

The ThinkVision's front bezel is more noteworthy than most. Next to the power button you'll find two buttons to control the speaker volume, and you'll use them: the ThinkVision 27 3D's sound is equivalent to a standalone speaker, and I never felt the need

ABOVE Even the back of the monitor exudes industrial chic

“Even if you work in 3D, most of the time you'll be using the ThinkVision 27 3D as a normal monitor – and it's excellent in this mode”

LEFT The sturdy stand offers plenty of tilting and adjustment options

BELOW Two buttons on the front control the volume of the impressive speaker

to switch to my Amazon Echo when playing music. The sound emanates from the grille at the bottom of the screen, with the eye-tracking cameras tucked into a lozenge-shaped area slap bang in the middle.

In terms of design, the ThinkVision 27 3D exudes industrial chic from the back as well as the front. At the rear, vertical lines help to disguise the central bulge that contains the sophisticated electronics inside.

Two USB-A ports and a 3.5mm jack sit on the left for easy access, along with a fold-out headphone stand. Things are more crowded at the rear, with two HDMI 2.1 ports, a DisplayPort and the main USB-C connector, which can deliver up to 100W of power to a connected laptop. There's no USB-B port, so no way to share a keyboard and mouse, but you do get a third USB-A port and a second USB-C port that can deliver 15W.

There's one more surprise. Lenovo hides a fourth USB-A port at the top rear of the unit; unpeel the cover and it sits there, ready for a webcam perhaps.

■ Time to buy?

The quality extends to the superb stand, which keeps the weighty panel rock steady, offers 155mm of height adjustment and swivels smoothly (and rotates into pivot mode). The stand even includes a place to hold your phone upright, but sadly it doesn't offer wireless charging.

So should you buy the ThinkVision 27 3D? You'll have at least a couple of months to decide, with Lenovo saying it will confirm on-sale dates in June. By that point I hope to have also reviewed Acer's rival offering, the SpatialLabs View Pro 27.

Clearly, the ThinkVision 27 3D isn't a mainstream monitor. And the fact the 3D effects only work over USB-C and on Windows diminish its appeal. Despite this, if your work involves 3D modelling then you may also find yourself saying a couple of choice words when you see the effect for the first time. **TIM DANTON**

SPECIFICATIONS

27in 3,840 x 2,160 IPS panel up to 60Hz • 3D resolution, 2,160 x 1,920 • 8-bit panel (16.7 million colours) • 4ms response time • HDR10 • DisplayPort 1.4 • 2 x HDMI 2.1 • USB-C upstream (100W) • RJ45 • USB-C 3.2 Gen1 downstream (15W) • 4 x USB-A 3.2 Gen1 • 2 x 5W speakers • pivot • 3.5mm jack • -45° to 45° swivel • -5° to 24° tilt • 155mm height adjustment • 615 x 223 x 413-568mm (WDH) • 8.9kg • 3yr limited warranty • part code, 63F1UAT3UK





Dell XPS 16 (2024)

You'll love the top-end 4K OLED touchscreen and thin design, less so the keyboard and the price

SCORE ★★★★★

PRICE As reviewed, £2,749 (£3,299 inc VAT) from dell.co.uk

The Dell XPS 16 is a beautiful laptop. Its machined aluminium chassis is so sleek you can almost forget it weighs 2.2kg, with super-thin bezels that mean the 16.3in display seems to hover in the air.

It's packed with powerful components, too. In our review sample's case, that was a Core Ultra 7 155H processor, 32GB of RAM and an Nvidia GeForce RTX 4070 GPU, but even the cheapest model – £1,849 inc VAT – includes the same processor, albeit with Intel's integrated Arc graphics and 16GB of memory. There are heaps of options: RTX 4050 or RTX 4060 graphics, up to 64GB of RAM and 4TB of storage, and the slightly faster Ultra 7 165H or top-end Ultra 9 185H processors. Businesses can also choose vPro versions, along with an upgrade to Windows 11 Pro.

I naturally put the RTX 4070 in my XPS 16 through the gaming wringer. At 1080p top settings, it averaged 73fps in *Borderlands 3*, 81fps in *Shadow of the Tomb Raider* and 128fps in *Civilization VI: Gathering Storm*. *Cyberpunk 2077* didn't run well until I dialled down the settings and activated Nvidia's DLSS 3 technology, but it was playable. Keen gamers should choose a laptop that sacrifices svelteness for meaty fans,

such as the Asus Vivobook Pro 15 OLED (see p60).

I got my kicks from playing older but still gorgeous strategic games such as *Endless Legend* on the lovely 4K OLED touchscreen. This costs an extra £300 over the standard 1,920 x 1,200 IPS panel, but it's money well spent as it also doubles the pixel count. An adaptive 48Hz to 90Hz refresh rate is welcome, too.

Dell claims a typical brightness of 400cd/m², which is plenty for an OLED screen

indoors, but we saw a slightly higher peak of 412cd/m². And that hit 635cd/m² when viewing HDR content. That's great to see, as is the ability to display 81% of the DCI-P3 colour gamut. The speakers are similarly strong, so

watching films on this laptop is a genuine treat.

However, there are frustrations that stop the new XPS 16 from being great. Dell says this "comfortable keyboard" offers "larger, deeper, touch-friendly keycaps and less space between keys [that] make typing more efficient", but in my experience it makes typing slower, more painful and more error-prone.

Then there are the capacitive touch keys that replace the function row. They look great, lighting up in ghostly white when you start typing, before slowly fading into nothingness when not in use. But with no give when you press them it feels like pressing on hard, cold aluminium.

My frustration was exacerbated by the touchpad. This isn't demarcated, so you have to guess where it begins and ends. You get the hang of it, but I just don't see the upside of this design.

Dell similarly jettisons ports such as USB-A, HDMI and RJ45, instead providing a 3.5mm jack, microSD card slot and three USB-C ports. These all support Thunderbolt/USB 4, unless you opt for the RTX

4070 which downgrades one to USB 3.2 Gen 2. Dell at least includes a USB-C adapter with a USB-A and HDMI port.

We'll end on good news, which is that battery life for such a powerful machine is excellent, lasting for 11hrs 3mins in our light-use test. That's the benefit of including a 99.5Wh battery. You also receive a year of on-site support plus cutting-edge Wi-Fi 7.

All of which makes the Dell XPS 16 a frustrating laptop. So much of it is top-notch – the OLED screen, the customisability, the power within – but it feels hamstrung by Dell's desire to make it look fantastic in photos. **ALEX WAWRO**

ABOVE The XPS 16 is a stunning-looking laptop with a gorgeous OLED screen

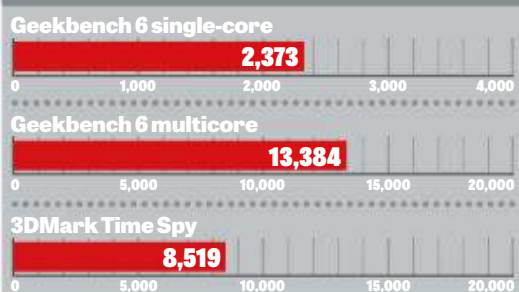
“So much of the Dell XPS 16 is top-notch, but it feels hamstrung by Dell's desire to make it look fantastic in photos”

LEFT The keyboard, however, leaves much to be desired

BELOW Typing on the XPS 16 can be a slow, painful process



BENCHMARKS



BATTERY LIFE



SPECIFICATIONS

16-core (6 P-cores, 8 E-cores, 2 LPE-cores) Intel Core Ultra 7 155H processor • 8GB Nvidia GeForce RTX 4070 graphics • 32GB LPDDR5X-7467 RAM • 16.3in 120Hz OLED touchscreen, 3,840 x 2,400 resolution • 1TB M.2 PCI-E Gen4 SSD • Wi-Fi 7 • Bluetooth 5.4 • 1080p IR webcam • 2 x Thunderbolt 4/USB-C 4 • USB-C 3.2 Gen 2 • 3.5mm combo jack • microSDXC 6 card reader • 99.5Wh battery • Windows 11 Home • 358 x 240 x 18.7mm (WDH) • 2.2kg • 1yr on-site warranty • part code cn96008cc

How we test

Laptops and PCs

We run a selection of benchmarks on all the PCs and laptops we test. Where possible, we use a cross-platform test so we can compare Windows and macOS machines, which is where both Geekbench and Cinebench R23 come into play. Both push the CPU to its limit, exposing how well cooled a system is.

We run extra tests for Windows systems. We use our own benchmarks to test photo-editing, video-encoding and multitasking speeds. We then switch to PCMark 10 to benchmark systems in office tasks, content creation and basic tasks such as web browsing and video calls. We also run 3DMark Time Spy and a selection of benchmarks in games such as *Metro Exodus* and *Shadow of the Tomb Raider*.

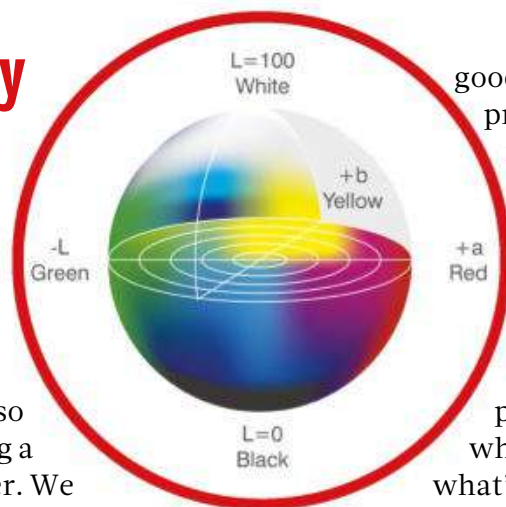
For laptops, we test battery life with Wi-Fi on and the screen brightness set to 150cd/m². We fully charge the laptops and drain them until they reach 5%. For Windows laptops, we will use a mix of PCMark 10's light-use and video-based tests, or a web surfing benchmark where a laptop automatically visits sites until the battery dies. We also use this test for MacBooks.



ABOVE We put PCs and laptops through our intensive set of benchmarks

Screen quality

In each laptop, phone, tablet and monitor review, you'll see our conclusions about the screen quality. Some of this will be subjective, but we also test each screen using a Display i1 colorimeter. We measure maximum brightness, colour accuracy and (for monitors) consistency – there may be a



good test of the processor and memory in particular, and include both a test for single-core and multicore performance. See below for a selection of scores to provide a reference of what's good... and what's not so good.

We also run 3DMark Wild Life test to give a measure of gaming performance.

As with laptops, we test phone and tablet battery life by playing a full-screen video until the battery runs out with the device. To simplify the test, we use Airplane mode. We set the brightness to as close to 150cd/m² as we can get in the device's settings.



LEFT We use a Display i1 colorimeter to measure sRGB gamut coverage and Delta E

BELOW We play a video with the screen set to 150cd/m² to test battery life



difference in, say, brightness from the middle and the edges of the panel.

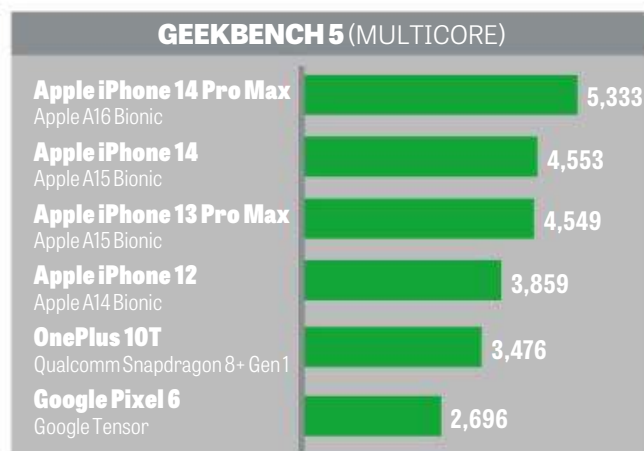
We also measure Delta E, which is a guide to how accurately panels display colours.

Anything under 1 is excellent and likely to be difficult for the human

eye to distinguish; between one and two is still strong; above this suggests a panel that you shouldn't trust for colour-accurate photo editing.

Phones and tablets

We run a selection of publicly available benchmarks on all the phones and tablets we review. First, we run Geekbench 5 and 6. These are a



What our awards mean



Recommended

This, quite simply, is a product we recommend you buy – if it meets your needs.



A-List

The best buy in its category right now. The product will also feature on our A-List, starting on p14. It's updated each month.



Labs Winner

Each month we run a group test, or Labs. This product has managed to beat all others to top position.

The pcpro.link

Throughout the magazine you'll see **pcpro.link** shortcuts. Enter these into the address bar of your browser and it will take you to a particular page, which will either be too long or awkward for us to publish or will take you to the precise shop from which to buy. If it's Amazon, note that we have an affiliate deal in place so we will receive a commission from each sale. This will never affect our verdict of a product, and if another reputable vendor is selling the product cheaper then we will use that instead.

Prices will vary

Prices we publish are correct on the day we publish, but we often see prices change, especially on sites such as Amazon. However, we do work with British PC retailers to ensure the prices we quote for their systems are correct. If the price isn't being honoured, contact us via letters@pcpro.co.uk.

GPU Cloud for Visualisation and AI

Scan Cloud takes all of our expertise in physical systems and packages it into a range of cloud services to give you virtualised GPU compute whenever and wherever you need it - on-site, off-site or even on a construction site.



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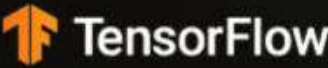
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NVIDIA GPU Instances

	H100	A100	L40S	A40	RTX 4090
ARCHITECTURE	Hopper	Ampere	Ada Lovelace	Ampere	Ada Lovelace
MEMORY	80GB HBM3	40GB or 80GB HBM2	48GB GDDR6	48GB GDDR6	24GB GDDR6X
PRICE PER WEEK (ex VAT)	£600	£300	£520	£240	£100

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HP Omen Transcend 14

If you're sticking with Asus or Razer gaming laptops out of habit, the HP Omen Transcend 14 may just change your mind



SCORE ★★★★★

PRICE As reviewed, £1,499 (£1,799 inc VAT) from hp.com/uk

The HP Omen Transcend 14 is part of a growing breed of Trojan Horse gaming laptops. On the surface, they look professional; the main giveaway comes when you start playing a game and the keyboard lights up in all its RGB glory.

HP sent us the black version of the Transcend 14 for testing, but you can buy it in white. I prefer dark colouring for laptops as they tend to age better, and this classy, anodised aluminium chassis will turn heads for years.

The main body is jet black, with the stiff lid in dark, corporate grey. A slender 17.9mm height coupled with a small footprint give it an ultraportable feel, although at 1.6kg you'll notice it in a bag. As with many modern gaming laptops, the rear juts out, but only by around 5mm. Enough for HP to squeeze in the legend "Designed and built for winning" on the surface, but in such small lettering that it feels like the gentlest of boasts.

The rear essentially acts as a giant exhaust, with grilles stretching across the whole width aside from two ports: one USB-C 3.2 Gen 2, one HDMI. You can use either for connecting a monitor, but HP anticipates that this is where most people will connect the chunky 140W power supply.

It's always a relief to see USB-A ports on a slim laptop, with two USB-A 3.2 Gen 2 ports on the right-hand side. Head to the left and you'll find the solitary Thunderbolt 4/USB-C 4 port, plus a combo 3.5mm jack. Add Wi-Fi 7 and Bluetooth 5.4 and this is one extremely well-connected laptop.

■ Fast as blazes

In our test machine, Intel's powerful Core Ultra 7 155H processor provides 16 cores. Here, it returned 6,813 in PCMark 10 and fine single-core results in Cinebench R23 and Geekbench 6 of 1,788 and 2,405 respectively. Those scores rose to 13,887 and 13,424 in the multicore sections.

We were also pleased to see a fast SSD in place, with barnstorming reads of 6,983MB/sec in CrystalDiskMark 8 and an equally impressive 5,325MB/sec for sequential writes. And thanks to that Thunderbolt/USB-C 4 port, you can add fast extra storage via one of the USB 3.2 Gen 2x2 drives we test from p72.

If I have one criticism it's that the 16GB of RAM is soldered on board and there's no way to add more, so that's what you're stuck with for the life of this machine. It's one of the reasons why I would spend an extra £200 on the version with a

ABOVE The Omen Transcend 14 offers plenty of punch for a decent price

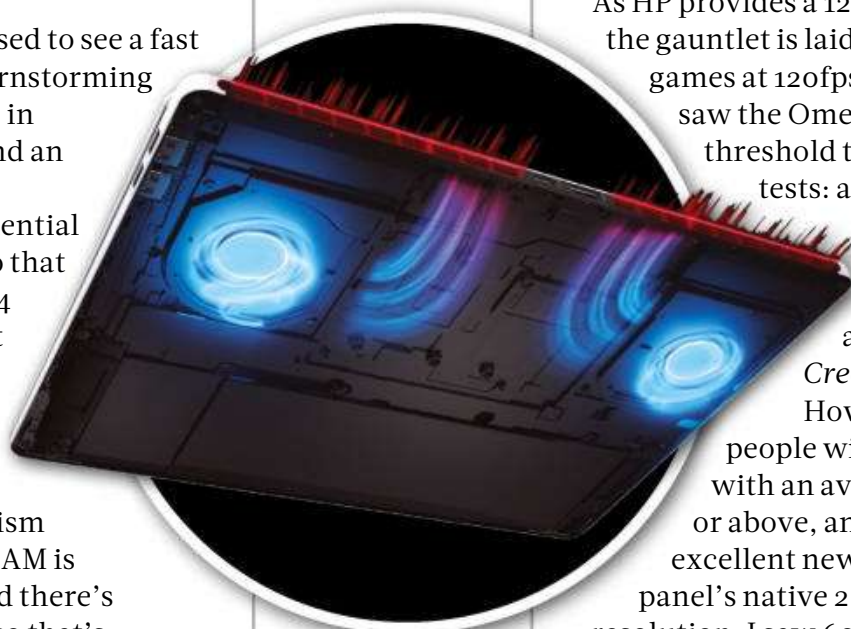
"Games, spreadsheets, films – it doesn't matter what you're doing on this laptop, the 14in OLED panel looks fantastic"

Core Ultra 9 185H processor, as this doubles the RAM and even upgrades the graphics card to an RTX 4070.

■ Mid-range gaming

You can also choose the Omen Transcend 14 with an RTX 4050, but as that only saves £100 it hardly seems worthwhile. If you can't stretch to the RTX 4070 version, at least stick with the RTX 4060 tested here. It may not be the fastest gaming card in existence, particularly in its mobile incarnation, but it gives this laptop gaming chops.

As HP provides a 120Hz screen, the gauntlet is laid down to play games at 120fps. Sadly, I only saw the Omen cross that threshold twice in my tests: at 1080p High settings for *Shadow of the Tomb Raider* and *Assassin's Creed Valhalla*. However, most people will be happy with an average of 60fps or above, and here I have excellent news: even at the panel's native 2,880 x 1,800 resolution, I saw 60fps or higher in *Assassin's Creed Valhalla*, *Shadow of the Tomb Raider* and *Dirt 5*. Those were at Ultra, High and Medium settings respectively, but it shows that



ABOVE The rear of the laptop acts as a giant exhaust

smooth gaming is possible – a 0.2ms grey-to-grey response time helps.

It's only when you move to more demanding games that you'll need to make sacrifices to resolution, settings or both. *Metro Exodus Enhanced* and *Cyberpunk 2077* only crossed the 60fps barrier at 1080p High, but those figures were without the aid of DLSS.

Bright points

Games, spreadsheets, films – it doesn't matter what you're doing on this laptop, the 14in OLED panel looks fantastic. HP quotes a maximum SDR brightness of 400cd/m², and my measurement of 408cd/m² backs that up, but HP reckons the Omen can hit 500cd/m² with HDR content. Certainly whites packed more of a punch in Netflix's *Our Planet* on the Omen Transcend than it did with other laptops I tested this month.

The panel sailed through our other technical tests, covering 100% of the DCI-P3 gamut with an average Delta E of 0.39. There's only one possible thing to dislike about this screen, and that's its glossy finish. Still, even in the full glare of the sun it's possible to see what's happening on the screen.

I also enjoyed listening to music on the Omen, and it's not often I say that about laptops. You'll miss out on fine details, but with a solid amount of bass and clear vocals most musical tastes are catered for.

Firm keys

Surely everyone will love the smooth, glass-coated touchpad? There are no fancy haptics going on here, with a "diving board" mechanism – the bottom physically dips when you press it – working well. It's large, too, measuring 125 x 80mm.

The keyboard is yet another strength. The keys have a crisp action with plenty of depth, and there's clear separation between them since the RGB edges sit lower than the key caps. In my ideal world, HP would have separated the cursor keys from the main area and provided a double-height Enter key, but gamers will love the 26-key rollover anti-ghosting.

Gamers should also spend time investigating the HP Omen software. This not only controls your keyboard colour preferences but performance settings during games, too; all our results were at Performance settings with Booster running during games. This clears unnecessary items from

GEEKBENCH 6 (MULTICORE)

Acer Predator Triton 14 Core i7-13700H, RTX 4070	14,626
HP Omen Transcend 14 Core Ultra 7 155H, RTX 4060	13,424
Samsung Book4 Ultra Core Ultra 9 185H, RTX 4070	13,061
Lenovo Legion 5 Slim Ryzen 7 7840HS, RTX 4070	12,336
Asus Zephyrus G14 Ryzen 9 8945HS, RTX 4060	12,246

HIGHER IS BETTER

METRO EXODUS ENHANCED (1080P, ULTRA)

Acer Predator Triton 14 Core i7-13700H, RTX 4070	67
Lenovo Legion 5 Slim Ryzen 7 7840HS, RTX 4070	67
HP Omen Transcend 14 Core Ultra 7 155H, RTX 4060	51
Asus Zephyrus G14 Ryzen 9 8945HS, RTX 4060	49
Samsung Book4 Ultra Core Ultra 9 185H, RTX 4070	49

HIGHER IS BETTER

BATTERY LIFE (LIGHT USE)

Samsung Book4 Ultra Core Ultra 9 185H, RTX 4070	13hrs 19mins
Lenovo Legion 5 Slim Ryzen 7 7840HS, RTX 4060	7hrs 46mins
HP Omen Transcend 14 Core Ultra 7 155H, RTX 4060	7hrs 15mins
Asus Zephyrus G14 Ryzen 9 8945HS, RTX 4060	6hrs 45mins
Acer Predator Triton 14 Core i7-13700H, RTX 4070	5hrs 17mins

HIGHER IS BETTER

DIRT 5 (1200P, ULTRA HIGH)

Acer Predator Triton 14 Core i7-13700H, RTX 4070	95
Lenovo Legion 5 Slim Ryzen 7 7840HS, RTX 4070	95
Asus Zephyrus G14 Ryzen 9 8945HS, RTX 4060	75
HP Omen Transcend 14 Core Ultra 7 155H, RTX 4060	74
Samsung Book4 Ultra Core Ultra 9 185H, RTX 4070	46

HIGHER IS BETTER

the memory and kills processes that might interrupt play.

You can also control the fan speed manually in the app, but in Performance mode they'll ramp up as needed. They get loud, but never to the point of irritation. More importantly, they keep the graphics card and CPU cool when pushed. I set the *Metro Exodus Enhanced* benchmark to run ten times, and its results dropped by 1fps over a 20-minute period.

Battery downside

There's one area of our testing where this laptop failed to impress, and that's battery life. A 71Wh unit sits inside, which is a good size but it still only lasted for 7hrs 15mins in PCMark's light-use office test. And if you actually want to game away from a power socket, good luck: it gave up in 58 minutes. At least it charges quickly, reaching 76% in an hour.

Looking ahead a few years when the battery is tired and its life unbearably short, you can replace it. HP supplies a detailed manual to explain how (only four crosshead screws stand in your way, but you'll need a prying tool), along with part numbers to make ordering easier for repairers. A good thing, as the warranty is a miserly year.

You can replace the microphones, SSD, touchpad, Wi-Fi module – pretty

much anything other than the RAM, in fact. That's great news, as it means the life of this laptop could stretch into the 2030s, and while we're always happy to see EPEAT Gold certification and the use of post-consumer recycled plastic (in the keycaps), what ultimately matters is that the machines we buy last us years – and have a second life once they stop meeting our expectations.

Final thoughts

There's one more test to tell you about: the webcam. Normally I would dismiss this with an "it's okay" remark, but HP has done a tremendous job here. It brings out an excellent amount of detail, and while we may still be cynical about the role of neural processor units (NPUs) in processors, they undoubtedly improve the performance of this laptop's webcam – the blurring effects are particularly good.

But the reason why this machine takes top spot on our gaming laptop list is the price. The Omen Transcend 14 is great value at £1,799, but I recommend you buy the Core Ultra 9 version (part code 9S190EA#ABU) if you can stretch to £1,999. **TIM DANTON**

SPECIFICATIONS

16-core (6 P-cores, 8 E-cores, 2 LPE-cores) Intel Core Ultra 7 155H • 8GB Nvidia GeForce RTX 4060 graphics • 16GB LPDDR5-7467 RAM • 14in non-touch OLED display, 120Hz, 2,880 x 1,800 resolution • 1TB M.2 Gen4 SSD • Wi-Fi 7 • Bluetooth 5.4 • 1080p IR webcam • Thunderbolt 4 with USB-C 4 • USB-C 3.2 Gen 2 • 2 x USB-A 3.2 Gen 2 • HDMI 2.1 • 3.5mm combo jack • 71Wh battery • Windows 11 Home • 313 x 234 x 17.9mm (WDH) • 1.6kg • 1yr limited warranty • part code 9R292EA#ABU

ABOVE Open the dark, corporate lid and you'll be met with a riot of RGB colours

BELOW Ports include two USB-A 3.2 Gen 2 and a Thunderbolt 4/USB-C 4 connector





PCSpecialist 17in Recoil

A basic design, but you can't argue with the power you're buying for the price – including liquid cooling

SCORE ★★★★★

PRICE **£2,438 (£2,926 inc VAT)** from [pcspecialist.co.uk/reviews](https://www.pcspecialist.co.uk/reviews)

How do you squeeze every last ounce of performance from silicon? Liquid cooling, of course, and PCSpecialist is offering this option on its latest Recoil gaming laptop. If you buy the version with an RTX 4080 or 4090 inside, you can pay an extra £96 for an external unit that pumps ionised water around the inside of the laptop to complement the standard heatsink and fans. And it works.

At this laptop's native 2,560 x 1,600 resolution, and with the most extreme settings, *Assassin's Creed Valhalla* leapt from 115fps to 127fps, *Cyberpunk 2077* from 82fps to 87fps and *Dirt 5* accelerated from 138fps to 157fps. Those are worthy increases, and were mirrored in the Graphics section of 3DMark Time Spy: 20,745 became 21,172. Bear in mind those were fine frame rates beforehand.

The water cooling focuses on the GPU rather than the CPU – in 3DMark, the CPU score remained the same – but I did see an increase in PCMark, which went from 8,887 to 9,295. That's because graphical acceleration comes into play during its tests.

Making the external water cooler work isn't child's play, and I advise going carefully through PCSpecialist's step-by-step guide. Keep an eye out for spills, as I had a couple of incidents during my time with the Recoil – partially because it's not clear if the reservoir is full, but partially my fault for not always following the advice.

BENCHMARKS

Geekbench 6 single-core

3,060

Geekbench 6 multicore

16,562

3DMark Time Spy Extreme

Normal cooling 9,675

External cooling 9,941

BATTERY LIFE

Light use 4hrs 2mins



You might decide that the standard setup is quite fast enough anyway, with Intel's most fearsome mobile chip also in place: the Core i9-14900HX. Add 64GB of top-end DDR5-5600 memory and the ludicrously quick 2TB Samsung Pro 990 SSD, and you have power on tap. For example, the 17in Recoil left Cinebench R23 in tatters with a multicore score of 22,016.

What you don't get is the same level of design refinement as, say, the HP Omen Transcend (see p54) or Asus ROG Strix Scar 18 (see issue 354, p54). Some attempt at styling comes via thin RGB strips at the rear, but it can't hide the fact that this is a chunky beast measuring 30mm at its thickest. Nor is its plain, dark grey finish likely to grab people's attention, with little effort made to soften its edges.

Once you factor in the 1kg power supply, on top of a weight not far off 3kg, this isn't a laptop you'll want to take on your travels. Even with a 99Wh battery, the longest life I saw was in PCMark's idle test, where it stretched to 4hrs 33mins. Typically it lasted between three and four hours on one charge, with the only plus point being quick recharge times: it reached 88% within an hour.

It's far more at home on a desk, with all the most permanent connectors clustered together at the rear of the laptop. This is where you'll find the water-cooling connectors, DC power input, RJ45 socket, HDMI output and the Thunderbolt/USB-C 4 port. Three USB-A ports, a full-size SD card slot and a pair of 3.5mm jacks sit on the sides. Wi-Fi 6E and Bluetooth 5.3 round out the connectivity.

The keyboard, complete with four-zone RGB lighting, is pleasant to type on, with a cushioned, quiet action, but it doesn't have the crispness of the best gaming

keyboards. Still, despite the presence of a number pad it remains spacious. I found the trackpad unpredictable at times, but in general it impresses thanks to its glass coating and sheer size.

It needs to be big to match the 17in screen, which once again has good and bad points. The good: a fantastic 240Hz refresh rate, peak brightness of 427cd/m² and 6469K to help whites look as they should. The bad: 72% colour coverage of the DCI-P3 gamut falls behind the latest tranche of top-end gaming laptops, which tend to cover 85% or higher. The 1080p webcam is similarly unexceptional.

Where PCSpecialist wins is for customisability and price. You can configure this machine with 32GB of RAM, a 2TB SSD and GeForce RTX 4070 graphics and still come in well under £2,000.

It's only because the company sent us the top-end model that it's so expensive. There's room for a second M.2 SSD as well, but I recommend that you choose this at the time of order as I tried and failed to battle past the 12 crosshead screws that keep the base in place.

If you know exactly what spec you want, and you don't care about aesthetics, then this gaming laptop can't be beaten for value. Especially when you factor in the three-year warranty. **TIM DANTON**

ABOVE This 17in laptop is packed with power, even if it won't win beauty pageants

“You might decide that the standard setup is quite fast enough, with Intel's most fearsome mobile chip also in place: the Core i9-14900HX”

SPECIFICATIONS

24-core (8 P-cores, 16 E-cores) Intel Core i9-14900HX processor • 16GB Nvidia GeForce RTX 4090 graphics (up to 25W boost) • 64GB Corsair DDR5-5600 RAM • 17in non-touch, IPS display, 240Hz, 2,560 x 1,600 resolution • 2TB Samsung Pro 990 M.2 Gen4 SSD • Wi-Fi 6E • Bluetooth 5.3 • 1080p IR webcam • Thunderbolt/USB-C 4 • USB-A 3.2 Gen 2 • 2 x USB-A 3.2 Gen 1 • HDMI 2.1 • 2.5GbE • SD card reader • 2 x 3.5mm jacks • 99Wh battery • Windows 11 Home • 382 x 273 x 30mm (WDH) • 2.8kg • 3yr warranty (6 months C&R, 1yr parts, 3yr labour)

BELOW An external water cooler ekes extra frames out of the RTX 4090 graphics





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Dell Inspiron 14 Plus (2024)

A budget laptop with bags of battery life and strong performance, even if there are inevitable sacrifices

SCORE ★★★★★

PRICE As reviewed, £749 (£899 inc VAT) from dell.co.uk

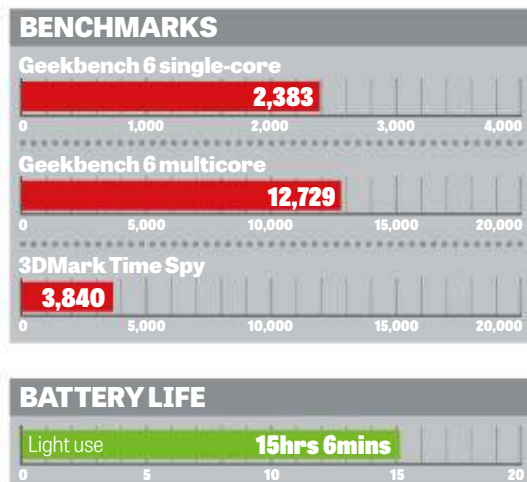
Dell's Inspiron brand isn't usually associated with exciting designs. With the new Inspiron 14 Plus, though, it really is what's inside that counts: with an Intel Core Ultra 7 155H processor, 16GB of RAM and a 1TB SSD, it can easily keep up with professional workloads. It's good value, too, at £899 inc VAT – or for the most demanding roles there's a Core Ultra 9 version with 32GB of RAM for £1,199 inc VAT.

While the overall look is hardly fresh, the ice blue aluminium exterior adds personality. It's thin (19mm) if not particularly light for its screen size at 1.6kg, but the chassis is well equipped with ports.

You get HDMI 1.4, a Thunderbolt 4/USB-C port, a pair of USB-A 3.2 Gen 1 ports and an audio jack. That should be enough to avoid the dongle life, although the single USB-C connector could become frustrating as the standard becomes increasingly commonplace.

There's also a fingerprint scanner at the upper right of the keyboard and a 1080p webcam above the screen, with a physical shutter to keep you safe from prying eyes. Video quality is soft but usable, albeit with a faint, pink cast to the image.

Part of the appeal of the Inspiron 14 Plus is its spacious 16:10 display. The standard model has a crisp resolution



of 2,240 x 1,400, while the Core Ultra 9 version has an even sharper 2,880 x 1,800 panel. The screen handles glare well, while a peak brightness of 367cd/m² is more than bright enough indoors. Films look vibrant despite its limited coverage of the DCI-P3 gamut (69%), and it has impeccable accuracy with an average Delta E of 0.23.

Dell's membrane keyboards divide opinion. I feel as if the soft touch slows down my typing, but the effect seems to be psychological rather than physical, as the 10FastFingers typing test showed little impact on my performance versus other laptops. The trackpad is a good size, at 4.6in across, and has a smooth feel with a satisfying click.

The Inspiron 14 Plus' twin speakers feature audio processing by Dolby Atmos Core and Waves MaxxAudio Pro, and go surprisingly loud. They'll certainly do for video calls without a headset, or even for movie streaming.

But the star here is the Intel Core Ultra 7 155H processor. To put its 12,729 multicore score in Geekbench into perspective, that even beats the 14in M3 Apple MacBook Pro, which trailed in at 12,018. And while a 34fps average in *Civilization VI: Gathering Storm* at 1080p on Medium settings is hardly stunning, it shows gaming potential.

It's even efficient, easily getting me through a day's work without the charger. In our battery tests, with the screen brightness set to 150cd/m², the laptop lasted an excellent 15hrs 6mins on a full charge.

This being a Dell

ABOVE The spacious 16:10 display is sharp, bright and colour-accurate



LEFT The cool ice blue finish adds an element of style

“To put its 12,729 multicore score in Geekbench into perspective, that even beats the 14in M3 Apple MacBook Pro”

BELOW Despite its slim proportions, the chassis provides plenty of ports

laptop, it comes with all the usual add-on software. You get Dell Update to check for driver updates, plus the MyDell tool, which includes the Dell Support assistant, presence detection settings, display and audio calibration settings, battery health reports and advanced network settings. Both hardware and software are covered by a single year of Dell's Premium Support warranty, with on-site service one to two business days after a remote diagnosis.

The new Inspiron 14 Plus is an impressive laptop for the money. It's not perfect: the screen could be punchier, the webcam is merely okay and the solitary USB-C port could become annoying. On the plus side, its powerful processor smashed through our benchmarks with ease, battery life is excellent, the funky ice blue finish adds a hint of style and the warranty is decent, too. It's a laptop that will

eat up demanding workloads, keep on running throughout a full day and probably even last you well into overtime hours.

MADELINE RICCHIUTO

SPECIFICATIONS

16-core (6 P-cores, 8 E-cores, 2 LPE-cores) Intel Core Ultra 7 155H processor • Intel Arc graphics • 16GB LPDDR5X-6400 RAM • 14in 120Hz IPS non-touch screen, 2,240 x 1,400 resolution • 1TB M.2 PCI-E Gen4 SSD • Wi-Fi 6E • Bluetooth 5.3 • 1080p webcam • HDMI 1.4 • Thunderbolt 4/USB-C 4 • 2 x USB-A 3.2 Gen 1 • 3.5mm combo jack • microSDXC 3 card reader • 64Wh battery • Windows 11 Home • 314 x 227 x 19mm (WDH) • 1.6kg • 1yr on-site warranty • part code, cn74702



TITANIUM



£499.99

CPU Intel Core i5 11400
MOB ASUS PRIME H510M-A
RAM 8GB DDR4 2666Mhz
SSD 240GB Sata3 SSD
HDD 1TB Sata3 HDD
OPT 24x DVDRW Dual Layer
GPU Intel Integrated HD630
CAS Fractal Core 1100
PSU 500W PSU
O/S Windows 10/11 64Bit

HELLFIRE



£999.99

CPU Intel Core i5 12400F
MOB ASUS PRIME B660M-A WIFI D4
RAM 16GB DDR4 3200Mhz
SSD 1TB WD SN770 M.2 Gen 4
GPU NVIDIA RTX3070 8GB
CAS GAMEMAX F15M MESH
PSU 750W Gold PSU
O/S Windows 10/11 64Bit

MERCURY



£599.99

2TB M.2 FREE UPGRADE

CPU Intel Core i5 12400
MOB ASUS PRIME B660M-A WIFI D4
RAM 16GB DDR4 3200Mhz
SSD 2TB ADATA Legend 800 M.2
GPU Intel Integrated HD730
CAS KOLINK Stronghold
PSU 500W PSU
O/S Windows 10/11 64Bit

COBRA



£399.99

2TB M.2 FREE UPGRADE

CPU AMD Ryzen 5 5600G
MOB ASUS TUF A520M-PLUS II
RAM 16GB DDR4 3200Mhz
SSD 2TB ADATA Legend 800 M.2
GPU AMD Radeon Graphics
CAS 1stPlayer D3-A
PSU 500W PSU
O/S Windows 10/11 64Bit

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Asus Vivobook Pro 15 OLED (2024)

A mobile workstation in disguise, this is a great alternative to far more expensive “pro” machines

SCORE ★★★★★

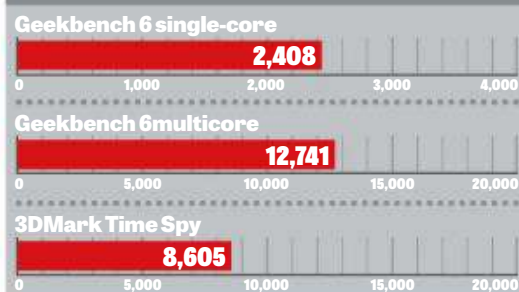
PRICE **£1,333 (£1,600 inc VAT)**
from uk.store.asus.com

This year’s update to Asus’ Vivobook Pro 15 makes one thing obvious: the days when you had to pay over £2,000 for a powerful mobile workstation are gone. Packed inside this 1.8kg monster you’ll find Intel’s top-end Core Ultra 9 185H processor and GeForce RTX 4060 graphics, and with Nvidia’s Studio software it’s ready to go with a bunch of professional apps.

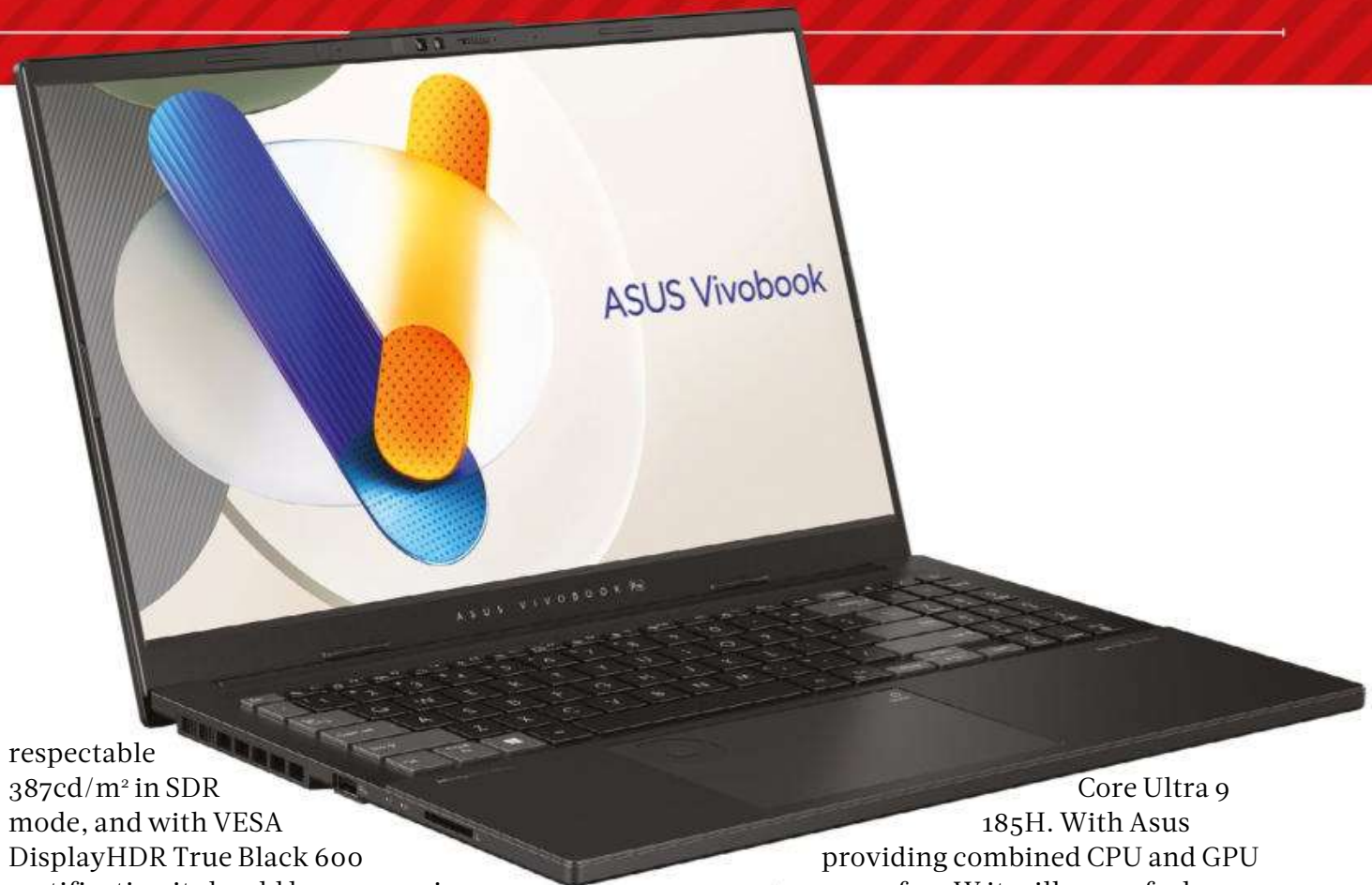
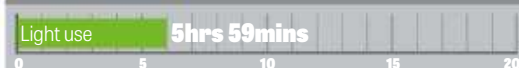
Asus certainly has its eye on designers here, even building a dial into the top left of the touchpad. If you’re dextrous enough to keep within its 3cm diameter then you can use it to whizz through timelines in Premiere Pro, adjust brush sizes in Photoshop and switch font sizes in PowerPoint. It’s no replacement for a hardware dial, but could be a time-saver on the move.

The Pantone-validated OLED display is another plus point. Not merely because it’s incredibly sharp, thanks to 2,880 x 1,620 pixels across a 15.6in diagonal, but also because it ships with presets for sRGB, DCI-P3 and Display P3. Or you can stick with its native colour gamut, which covers 99% of the DCI-P3 space (with a 115% volume) and reproduces colours with near-perfect accuracy. It hit a

BENCHMARKS



BATTERY LIFE



respectable 387cd/m² in SDR mode, and with VESA DisplayHDR True Black 600 certification it should be no surprise that films look incredible.

There’s a fine pair of speakers here, too, with vocals coming through with particular clarity. That quality extends to the 1440p webcam. If you find, as I did, that the captured audio isn’t as clear as you hoped, head into the settings within the MyAsus app and switch off all the AI enhancements.

This app is also where you’ll find the colour gamut options and control over the fan settings. I don’t see the point of buying a laptop as powerful as this and not putting those fans into Performance mode; they’re noisier, but you’re rewarded with significantly faster frame rates in games: *Metro Exodus Enhanced*’s averages went up by over 10%, for instance, moving from 61fps at 1080p High settings to 68fps. And 3DMark Time Spy jumped from 7,969 to 8,605.

If you buy this laptop then you’ll get faster results still, as the system Asus sent me had RTX 4050 graphics rather than RTX 4060. As mentioned in the HP Omen Transcend review (see p54), you’ll struggle to get above 120fps to take advantage of the screen’s 120Hz refresh rate in most games – I only breached 100fps in *Cyberpunk 2077* at 1080p medium and *Shadow of the Tomb Raider* at 1080p High – but all current AAA games will play fluidly at reduced settings.

Our test machine came with a Core 7 Ultra, but shipping units include the

ABOVE At 1.8kg this is no lightweight, but in return you get pro levels of power



LEFT The huge touchpad includes a dial for use in apps such as Photoshop

“With a crisp keyboard, complete with number pad, this is a laptop computer that has appeal across the spectrum”

BELOW Asus includes every port you’ll need on the right-hand side of the chassis



Core Ultra 9 185H. With Asus providing combined CPU and GPU power of 125W it will never feel sluggish. The thick – by modern standards – chassis also has plenty of room for a chunky heatsink and fans, but the drawback is battery life. It lasted for 8hrs 19mins in PCMark’s video-rundown test, but switching to Modern Office dropped that to 5hrs 59mins. You’ll need to take the meaty 200W power supply with you.

This has its own power socket, which sits on the right-hand side of the chassis along with Thunderbolt 4, USB-C and USB-A ports. And a gigabit Ethernet connector, 3.5mm jack and HDMI 2.1 output. Safe to say it’s crowded. A single USB-A port and SD card reader sit on the left, along with the heat exhaust vents.

With a crisp keyboard, complete with number pad, this is a laptop computer that has appeal across the spectrum. I can see reasons for writers, gamers, designers and video editors to reach for their wallets.

You’ll notice its bulk and weight when travelling, but sometimes only a powerhouse will do. And that’s exactly what the Asus Vivobook Pro 15 OLED is. **TIM DANTON**

SPECIFICATIONS

16-core (6 P-cores, 8 E-cores, 2 LPE-cores) Intel Core Ultra 9 185H • 8GB Nvidia GeForce RTX 4060 graphics • 16GB DDR5-5600 RAM • 15.6in 120Hz OLED non-touch screen, 2,880 x 1,620 resolution • 1TB M.2 PCI-E Gen4 SSD • Wi-Fi 6E • Bluetooth 5.3 • 1440p IR webcam • Thunderbolt 4/USB-C 4 • USB-C 3.2 Gen 2 • 2x USB-A 3.2 Gen 1 • 1GbE port • SD 4.0 card reader • 3.5mm combo jack • 75Wh battery • Windows 11 Home • 356 x 235 x 19.9mm (WDH) • 1.8kg • 1yr C&R warranty • part code, N6506MV-MA026W

Asus Vivobook S16 OLED

A sleek laptop that couples powerful components with a high-quality screen – and the price is right

SCORE ★★★★★

PRICE **£1,000 (£1,200 inc VAT)**
from [scan.co.uk](https://www.scan.co.uk)

Two months ago, Samsung won five stars for its Galaxy Book4 Ultra (see issue 355, p64), a stylish Core Ultra 7 laptop with a 16in 120Hz OLED screen and 16GB of DDR5 RAM for £1,699. Now we have Asus' £1,200 Vivobook S16 OLED, with a 1TB SSD rather than 512GB – and it's even lighter at 1.5kg versus 1.6kg. How, you might well wonder, has it done that?.

On first sight, there are no obvious sacrifices. This is an all-metal chassis that has passed five of the MIL-STD tests, and although I would prefer the screen to have more protection – the lid flexes under duress – there are no other weak points. It isn't as sleek as its rival, at 15.9mm rather than 12.5mm, but this remains a svelte laptop in your choice of blue or black.

Nor does Asus skimp on ports, with an HDMI output, microSD card slot, 3.5mm combo jack and two Thunderbolt 4/USB-C 4 ports on the left, while two USB-A ports sit on the right. Wi-Fi 6E and Bluetooth 5.4 complete the lineup. Even the 1080p webcam is top quality, with the neural processing unit in Intel's Core Ultra chip adding effective blurs.

The external sign of AI is Microsoft's Copilot key on the keyboard, and Asus also squeezes a number pad into the wide chassis. That makes the

single-height Enter key more difficult to hit and shifts the huge trackpad to the left (palm rejection worked brilliantly, though). I'd have liked more travel and feel to the keys, while a lack of contrast (dark grey characters on a light grey background) makes them tricky to see in dark conditions. There is a backlight, complete with single-zone RGB colours, but it's geared towards style rather than readability.

That's in contrast to the 3,200 x 2,000 OLED panel, which is a brilliant inclusion at this price. It covers a wide gamut, 99% of DCI-P3, and you can instruct Windows to run it at 60Hz or 120Hz, or let apps decide. For better or worse, there's no touch support.

At lower brightnesses the panel's whites aren't as crisp as I'd like, but pushing the screen up to its 387cd/m² peak solved that problem. It's a

pleasure to watch films on this display too, with rich blacks and up to 500cd/m² brightness for whites in HDR; while the speakers pack little bass they're otherwise solid performers.

As is the Vivobook itself, which is no surprise when Asus feeds the Core Ultra 7 155H with up to 45W. It nudged ahead of the Book4 in Geekbench 6, helped by stronger fans in that thicker base, but in practice I defy anyone to notice the difference. Intel's Arc graphics provide enough 3D acceleration for older games. Don't expect to take advantage of the 120Hz refresh rate, however, with *Shadow of the Tomb Raider* averaging 45fps at 1080p and the lowest graphics settings.

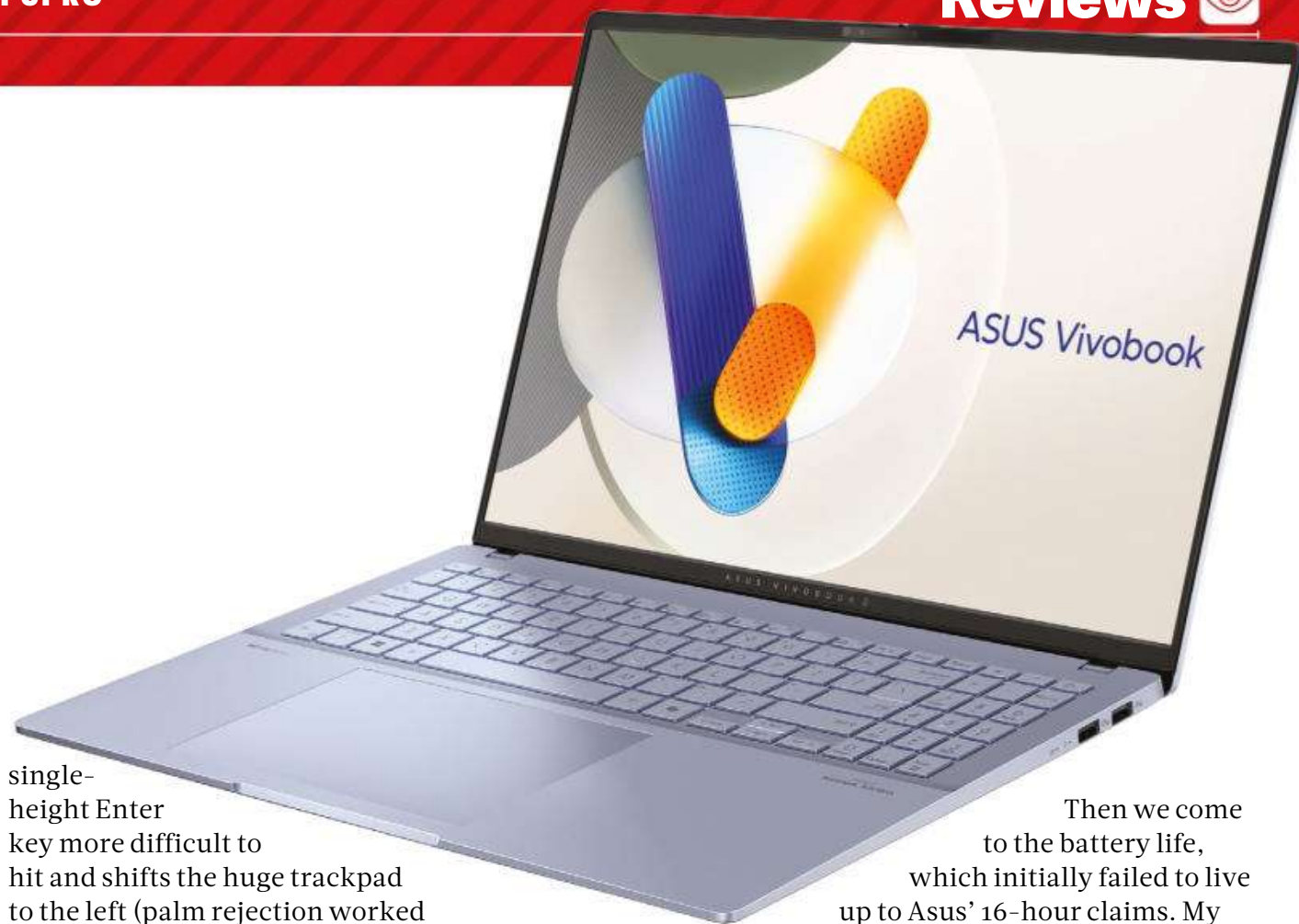
ABOVE The wide-gamut OLED display is a brilliant inclusion for the price



“The 3,200 x 2,000 OLED panel is a brilliant inclusion at this price. It covers a wide gamut, and you can run it at 60Hz or 120Hz”

LEFT We like the light blue version, but you can also buy it in black

BELOW Rivals are thinner still, but this is a sleek laptop and has plenty of ports



Then we come to the battery life, which initially failed to live up to Asus' 16-hour claims. My first two tests saw the 75Wh battery die after a dismal five hours. Fortunately, after logging into the MyAsus software, a BIOS update appeared to solve the problem, with the laptop reaching a far more respectable 9hrs 10mins in PCMark's light-use Modern Office test.

This is also your gateway to extending the single-year warranty. Paying £90 upgrades that to two years of on-site cover, which is definitely worth considering. You can make some repairs and upgrades yourself – the SSD and battery are both easy to access, while more confident repairers can even replace the display – but sadly the 16GB of memory is

embedded onto the motherboard. And there's no spare slot to add more.

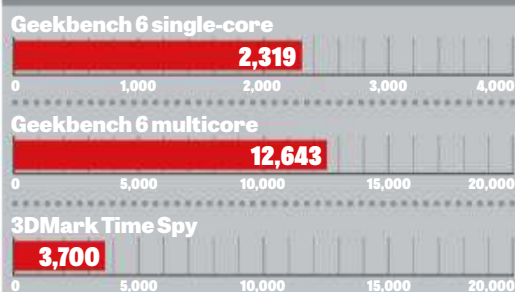
I don't love the keyboard, and wish the battery life was better without recourse to firmware upgrades, but at

this price – considering the all-round quality of the components and the amount of speed on offer – I can only give this laptop top marks. It's simply astonishing value. **TIM DANTON**

SPECIFICATIONS

16-core (6 P-cores, 8 E-cores, 2 LPE-cores) Intel Core Ultra 7 155H processor • Intel integrated Arc graphics • 16GB LPDDR5X-8400 RAM • 16in 120Hz OLED non-touch screen, 3,200 x 2,000 resolution • 1TB M.2 PCI-E Gen4 SSD • Wi-Fi 6E • Bluetooth 5.4 • 1080p IR webcam • 2x Thunderbolt 4/USB-C 4 • 2x USB-A 3.2 Gen 1 • 3.5mm combo jack • 75Wh battery • Windows 11 Home • 354 x 247 x 15.9mm (WDH) • 1.5kg • 1yr RTB warranty • part code, S5606MA-MX008W

BENCHMARKS



BATTERY LIFE





Netgear Orbi 970

This ultra-premium mesh is loaded with potential, but Wi-Fi 7 isn't mature enough to justify the huge price



SCORE ★★★★★

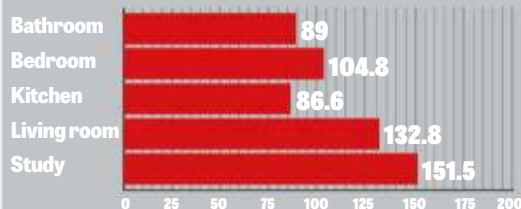
PRICE 2-pack, £1,250 (£1,500 inc VAT) from netgear.com

Whenever a new Wi-Fi standard comes along, you can expect Netgear to be one of the first companies out of the traps with high-end hardware that showcases the potential of the new technology. You can expect something else, too: that its products will come at a price guaranteed to scare off all but the most ardent early adopters.

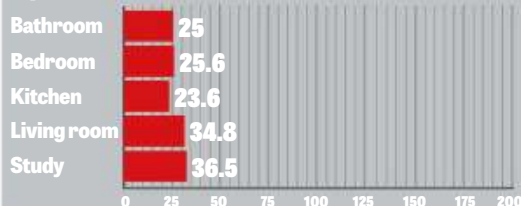
Indeed, we've already seen the Netgear Nighthawk RS700S (see issue 353, p76) – the first standalone Wi-Fi 7 router to reach these shores, yours for a mere £800 once you factor in VAT. Now Netgear has followed up with the Orbi 970,

WI-FI BENCHMARKS

Downloads (MB/sec)



Uploads (MB/sec)



a premium Wi-Fi 7 mesh that sets a couple of records for the *PC Pro* labs.

Big design, big budget

The Netgear Orbi 970 makes a striking first impression: these units are physically the largest Wi-Fi stations we've ever encountered. Each one stands 294mm tall, with a triangular footprint that extends to a maximum of 144mm. That sheer size makes them hard to hide away: they do, however, have mounting holes on the bottom, so you can attach them to a ceiling or a wall, and you can choose a low-key black casing rather than the futuristic white design I tested.

And you probably don't need to fill your house or office with Orbi stations. A twin-pack is supposedly enough to provide Wi-Fi coverage over an area of up to 610m², while three units will cover up to 930m², which should only be necessary for mansion dwellers, those with particularly unusually shaped apartments or small businesses that have a surprisingly large building.

That's just as well, because the Orbi 970 is also the most expensive mesh we've ever reviewed. You'll pay a staggering £1,500 inc VAT for two stations, or if you need three that will be £2,200, thank you very much.

ABOVE One of the fastest Wi-Fi systems we've tested – and one of the most expensive

Bags of bandwidth

For that exceptional price you get an exceptional set of hardware. The Orbi system claims an aggregate wireless throughput of 27Gbits/sec – more than ten times the bandwidth of a typical Wi-Fi 6 connection.

It's divided up across four radios, including a 2.4GHz one for your legacy IoT widgets, a frontside 5GHz network rated at up to 5.8Gbits/sec and an ultrafast 6GHz network supporting

speeds of up to 11.5Gbits/sec. The fourth radio is another 5GHz transmitter dedicated to backhaul communications, ensuring that the main network isn't bogged down by data being passed back and forth between units.

Needless to say, those quoted speeds all assume perfect laboratory conditions, which you'll never encounter in the real world. They also assume you're using Wi-Fi 7 with 4x4 MIMO; in reality, most connecting clients will probably be limited to 2x2 MIMO, but that's still enough to whizz data over the airwaves at tremendous speed.

For those who prefer a traditional wired connection, the Orbi 970 naturally packs best-in-class Ethernet connectivity. The main unit has twin

“The Orbi system claims a wireless throughput of 27Gbits/sec – more than ten times the bandwidth of a typical Wi-Fi 6 connection”



ABOVE The striking mesh stations are available in black as well as white

10GbE ports, one for your internet line and one for an ultrafast LAN connection, while a further four 2.5GbE sockets allow additional multi-gig device connections. The remote stations each have their own pair of 2.5GbE ports, plus another 10GbE connector that can be used as a wired backhaul link, for peak performance even at long range.

■ An ambivalent app

Getting set up is, as ever with Netgear equipment, made easy by the Orbi app. This automatically detects the network and walks you through the initial configuration; you can then manage the system within the same app, or use the Orbi's web portal. I have to say, though, the whole software platform is starting to show its age. The app and web interface have completely different layouts and feature sets, and I don't find either particularly well laid out or intuitive.

There are some good features here. I've always been a fan of the Wi-Fi analytics module in the smartphone app, which tracks signal strength and interference around your home to help you pick the best spots for your Orbi stations. Netgear's integrated VPN server also provides an easy way to get remote access to your home network.

There's still no outbound VPN support, however, nor any support for USB storage or a failover internet connection. I'm also irked by the limited wireless configuration, which gives you no control over which devices connect to which Orbi stations, or which radio bands they use. At this price, I expected more and I think you should too.

Plus, on a related value-for-money subject, the Netgear Armor online security module is only included for the first year, after which you have to pay £85 a year to keep it going. Netgear's parental controls are provided as a one-month trial, after which they cost another £50 per year. Considering the price of the system itself, I would expect these major features to be included for a full year, or at least that the initial service period would last longer.

■ Fast, and hopefully faster

The Orbi 970 isn't the first Wi-Fi 7 system we've reviewed – it follows the Nighthawk RS700S and the Amazon Eero Max 7 mesh (see issue 352, p68). However, those systems arrived so early that there was no Wi-Fi 7 client hardware available to test them with. This month, to test the Orbi 970, I was able to upgrade my trusty test laptop with a brand-new Intel BE200 Wi-Fi 7 card, with support for 2x2 MIMO and connection speeds up to 5.8Gbits/sec.

Thus equipped, the graph opposite shows the download speeds I measured in various rooms of my own home from a two-node Orbi system. And those speeds are exceptional; we've had to redraw the graphs to fit them in, with the Orbi 970 proving one of the fastest Wi-Fi systems we've ever tested. It raced way ahead of Netgear's previous flagship mesh, the Wi-Fi 6E Orbi RBKE963 (see issue 331, p68), for instance, beating that already speedy device by an average of 71%.

At the same time, it's conspicuous that the Orbi didn't derive much advantage from the new Wi-Fi 7 technology compared to a regular Wi-Fi 6 connection. Top speeds over Wi-Fi 7 were higher at short range, but dropped off as I moved further away; this probably has little to do with the Wi-Fi standard itself, and merely reflects the fact that the Orbi units seem to prefer using the 6GHz band for Wi-Fi 7, which normally offers higher data rates but worse penetration than the 5GHz band.

The good news is that this doesn't represent the peak of the Netgear Orbi 970's capabilities. Although you can buy an Intel BE200 card today, we're still waiting for a driver update that will enable Wi-Fi 7's new MLO operating mode, which boosts performance by allowing devices to communicate across multiple radio bands at once. The Orbi 970 is also awaiting a firmware update to add client-side MLO support, while Windows 11 isn't slated to fully support Wi-Fi 7 until the forthcoming 24H2 update. Realistically we may need to wait until the tail end of this year before all the necessary elements are in place to realise the full performance potential of the Orbi 970.

■ Slowly does it

It's frustrating that we still can't take full advantage of



ABOVE A twin-pack can provide Wi-Fi coverage over an area of up to 610m²

BELOW The main unit has twin 10GbE ports, plus a further four 2.5GbE sockets

the new wireless standard, but there are very few people out there who really need Wi-Fi 7 right now. In time, it's hoped that its huge bandwidth and low latency will open up a new era of live VR, game streaming and remote computing. Today, though, a mid-price Wi-Fi 6 setup should easily meet the needs of any household, and even most small businesses.

Even if you're eager to get a head start on Wi-Fi 7, we'd recommend that you sit tight for a while longer. By the time next-generation performance is achievable there will probably be a wider range of systems to choose from. Based on its impressive specification, it's quite possible that the Orbi will lead the pack for sheer performance, but competitors may well offer nicer management interfaces – and lower prices.

DARIEN GRAHAM-SMITH

SPECIFICATIONS

Shared: Quad-band 2.4GHz/5GHz/5GHz backhaul/6GHz Wi-Fi 7 router • 12 x internal antennas • 144 x 131 x 294mm (WDH) • 1.8kg • 2yr warranty • part code RBE972SB. **Router:** 2.6GHz quad-core processor • 10GbE internet WAN port • 10GbE Ethernet LAN port • 4 x 2.5GbE ports. **Satellite:** 10GbE Ethernet LAN port • 2 x 2.5GbE ports





Asus RT-AX57 Go

Tiny, lightweight and surprisingly speedy, this portable router does far more than you'd expect

SCORE ★★★★★

PRICE £75 (£90 inc VAT) from amazon.co.uk

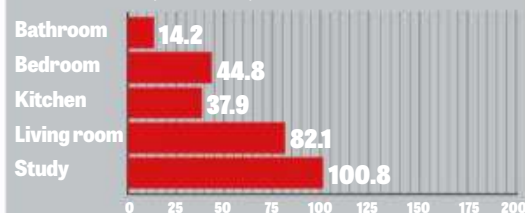
Most routers sell themselves on speed or clever configurable features. The diminutive Asus RT-AX57 Go aims instead for portability. It's a pocket-sized router designed to provide a Wi-Fi 6 network wherever you need it, and then to travel home with you at the end of the day. It could be perfect for teams at trade shows, pop-up venues or in ad hoc workspaces, while larger company departments might find it handy for travelling assignments.

Although it's designed for life on the road, the RT-AX57 Go isn't a true go-anywhere device. For one thing it doesn't have an internal battery, so you'll need to power it from an external source. However, since the power connector uses the USB-C standard, you can run it off any phone charger that supports USB PD, or even a portable battery pack.

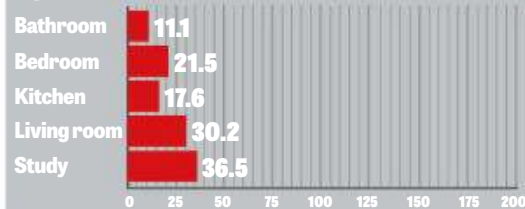
It's also notable that the RT-AX57 Go doesn't have a SIM slot – a surprising omission considering the design brief. Instead, a gigabit Ethernet WAN port lets you connect a fixed broadband line if you have one to hand; if you don't, you can use the single USB-A socket to connect a 5G dongle, or plug in an Android smartphone and share your data service. If that's not required,

WI-FI BENCHMARKS

Downloads (MB/sec)



Uploads (MB/sec)



In all, the RT-AX57 Go does much more than you'd expect from a device of this size and price, and it also delivers remarkably good Wi-Fi performance.

Unsurprisingly, it's limited to Wi-Fi 6 – you won't get 6E, and certainly not 7 at this price – but it supports a reasonable maximum transmission speed of 2.4Gbits/sec, and in my tests I found it was impressively able to match the speeds of full-size domestic routers. At close range I measured a download speed of 101MB/sec; from a room away I still saw 45MB/sec, and even in the hard-to-reach bathroom at the back of the house I got a perfectly usable 14MB/sec. So while the RT-AX57 Go might not fill a convention hall, it could well be all you need for a reasonably sized catchment area.

It's also worth mentioning that the RT-AX57 Go supports Asus' AiMesh system, so you can partner it with other Asus routers when you're in the office – perhaps bigger ones

with faster Wi-Fi radios and more Ethernet ports – and then just unplug it and take it offsite as required.

I do have a few niggles. The lack of a battery and a SIM slot doubtless keeps the price down, but it means you can't realistically use the router without at least one or two cables and attachments. That diminishes the neatness of the whole affair – and at 210g it's so light that when I attached my network and LAN cables together, they dragged it off the desk.

If you're looking for the cleanest, simplest way to share a mobile internet connection, you might be happier just using the hotspot feature on your phone. Your other option is to go for something like the Netgear Nighthawk M6. That really does offer portable wire-free internet, with integrated 5G and a touchscreen, although at £760 inc VAT it's in a different price bracket.

But if you simply need a portable router for occasional lightweight duties, ideally for settings where there's already an internet line in place, the Asus RT-AX57 Go does everything you need – and far more besides – for a delightfully low price.

DARIEN GRAHAM-SMITH

SPECIFICATIONS

Dual-band 2.4GHz/5GHz Wi-Fi 6 router • 4 x streams • 2 x GbE • USB Type-A 3.2 Gen 1 • 120 x 120 x 22mm (WDH) • 1yr limited warranty • part code 90IG08N0-MU9C00

you can use this socket to share a USB storage device, host a printer or run media services. A single gigabit LAN socket also lets you connect additional network clients.

In all it's a very versatile network hub, and that's because the RT-AX57 Go runs the same standard Asus firmware as all the company's routers. That means the full feature set is on the table, including integrated network security and parental controls, extensive QoS management and all the Wi-Fi configuration settings you could possibly ask for.

It also means you get Asus' outstanding VPN support. If you wish you can set up the RT-AX57 Go as an incoming VPN server (using either OpenVPN or the faster WireGuard protocol) to connect to your local

network from anywhere out on the internet. Or it can operate as an outbound gateway for third-party VPN services courtesy of the VPN Fusion feature, which lets you configure up to 16 different server locations and choose which clients will use each one. Settings for

Surfshark are integrated into the router interface, but you can use any provider that supports OpenVPN or WireGuard.

One feature that's distinctive to the RT-AX57 Go is something Asus calls Guest Network Pro. This lets you add a captive portal to the guest network with your own branding, acceptable use policy and so forth, which visitors must accept to gain access. It's a great touch for the intended market, but if you don't need it you can also choose to run the guest network as a dedicated network for kids, with preset parental controls; as an isolated network for untrusted gadgets; or as an always-on VPN connection, allowing devices to easily hop between direct ISP access and a protected link simply by switching SSIDs.

ABOVE The dinky RT-AX57 Go is full of features considering its size and price

“The RT-AX57 Go does a lot more than you'd expect, and it also delivers remarkably good Wi-Fi performance”

LEFT Wi-Fi speeds compare well to other less portable rivals

BELOW A gigabit LAN socket lets you connect additional network clients





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£177

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Norton Utilities Ultimate 2024

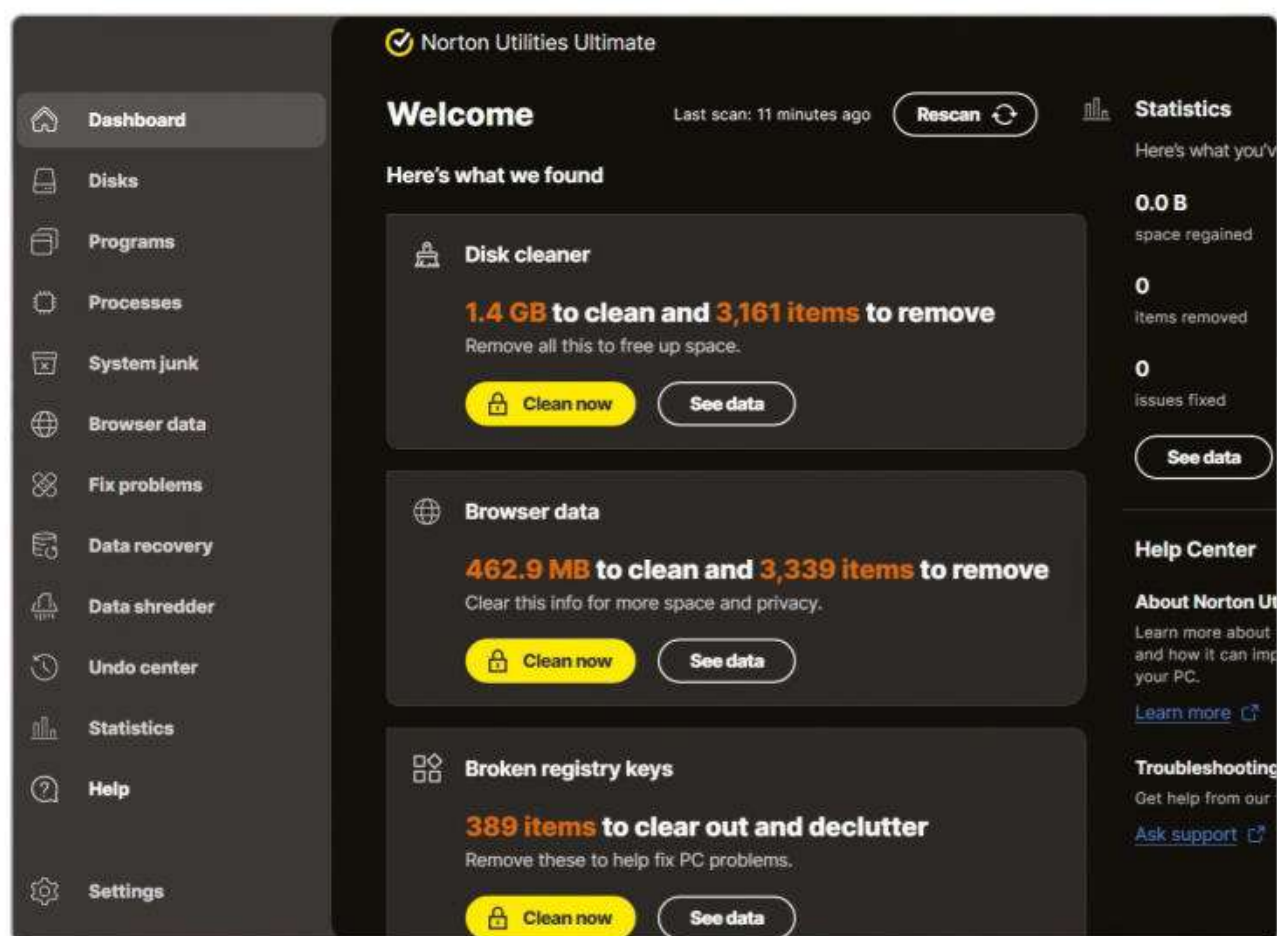
The Norton name has been synonymous with PC optimisation tools and security utilities for decades. This month, we're giving every reader a full copy of Norton Utilities Ultimate 2024, which you can install on up to ten devices and use for the next year.

■ **10-device, one-year licence worth £40**
■ **norton.com REQUIRES Windows 7 or later; 100MB hard drive space; online registration**

Norton Utilities comprises numerous components, and can be used in several different ways. If you prefer not to get involved with the nitty-gritty of configuring everything yourself, there are one-click options for getting quick results. Or you can let software analyse your PC and work through its recommendations one by one.

The Dashboard presents an overview of your system, with a breakdown of any issues detected, such as junk files wasting space or unnecessary startup programs slowing down your computer. You can remedy these in a flash by clicking the Repair All button, or select which you would like to fix on a case-by-case basis.

The suite also includes Norton Utilities' Toolbox, where you'll find numerous cleanup

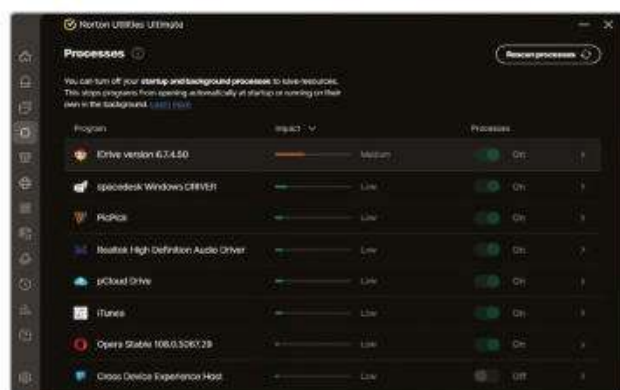


and optimisation tools, which again can be used in automatic or manual mode. There's a huge range of utilities to choose from, including five cleanup options: an all-in-one cleanup, an internet cleanup, a Windows cleanup, a Registry cleanup and an advanced uninstaller.

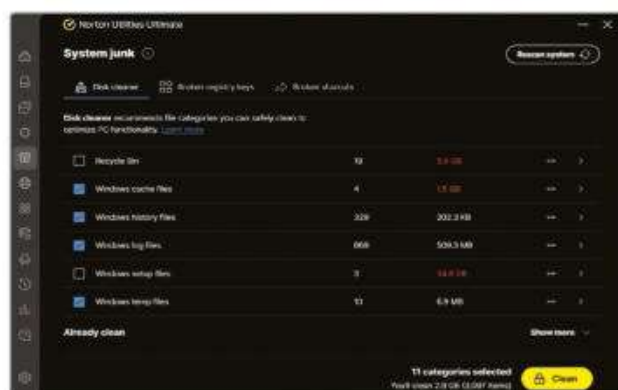
You'll find other tools in the Speed Up section, including a memory optimiser, startup time reducer and defragmentation utility. The Protect section is

home to privacy-related tools, including a secure file shredder, while you'll find fixes for common computer problems in the Recover section.

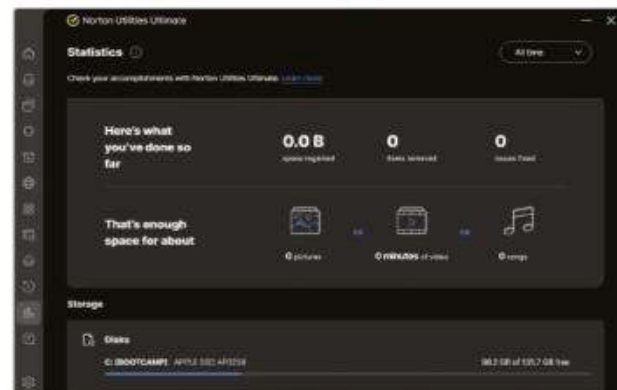
It's worth spending some time exploring all that the suite offers, but you might like to head first for the Real-Time Boost utility. This uses a series of algorithms to optimise your computer's power use, boost CPU performance, free up memory and much more; the results can be impressive.



ABOVE If your PC is running slow, check out the Processes list to see what's consuming resources and disable any you don't need



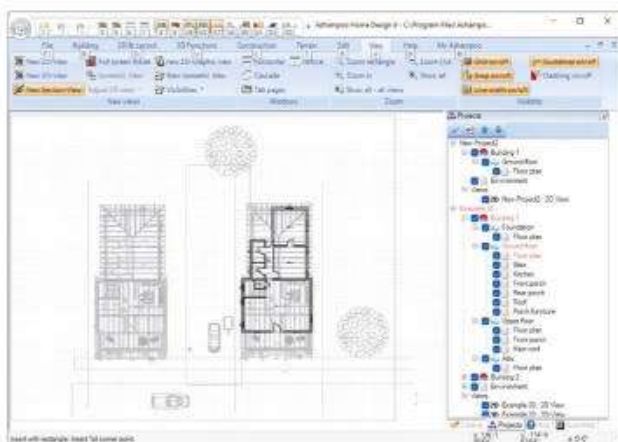
ABOVE Norton Utilities Ultimate can help you to identify wasted space on your drives and clear out unneeded items with a click



ABOVE The Statistics page makes it easy to keep an eye on the changes you make and the improvements they've made to your system

Ashampoo Home Design 9

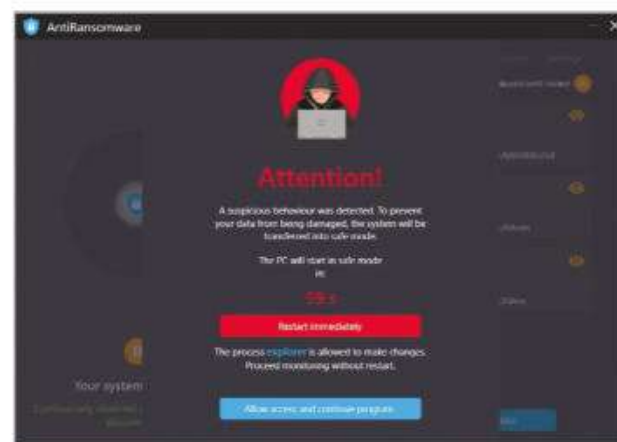
- Everything you need to plan home renovations or a complete building project
- Includes templates to get you started, with options to work in 2D, 3D or a combination view
- Calculates sizes for you, produces 3D visualisations of your project and can even render fly-around videos of buildings you create



Full product worth £44 ashampoo.com
REQUIRES Windows 8 or later; 500MB hard drive space; in-application registration

Abelssoft AntiRansomware 2023

- Monitors your computer for ransomware and raises the alarm at the first sign of suspicious activity
- Scans your main data folders, plus any others that you specify
- Automatically reboots your computer in Safe Mode, and warns you by email if you're not around to take action



Full product worth £30 abelssoft.com
REQUIRES Windows 7 or later; 20MB hard drive space; in-application registration

ASComp Secure-PDF 2



Full product worth £19 ascomp.de
REQUIRES Windows 7 or later; 100MB hard drive space; in-application registration

- Secure your PDF files with password protection and 256-bit encryption
- Limit what users can do with your documents, such as preventing them from printing them out or copying the contents
- Add visible watermarks to instantly affirm ownership of your work

WebSite X5 Go 2024



Full product worth £19 websitex5.com
REQUIRES Windows 7 or later; 300MB hard drive space; in-application registration

- Create top-quality responsive websites, even if you have no design or coding experience
- Includes themed templates for blogs, sports, animals, food, movies, web portals and more
- Drag, drop and crop elements on the page, with blocks for text, images, galleries, video, audio, widgets and more

PCmover Express 11.3



Full product worth £25 laplink.com
REQUIRES Windows 7 or later; 250MB hard drive space; in-application registration

- Migrate files, data and settings from one PC to another to simplify upgrading your system
- PCmover Express scans your old computer to help you decide what to transfer
- Install a second copy of PCmover Express on your new PC and transfer your files across your home network

How to claim your bonus software

1 Visit pcprodownload.co.uk. First, enter the issue number (357 this month). Next, enter your email address and the coupon code printed on the cover's spine (or directly on the front cover of digital issues of the magazine). We'll then send an email to confirm that your code has been registered. Follow the instructions in the email to access the download area.

2 Once you're in the download area, you can access this month's bonus software by navigating to the relevant product page and clicking the red Install button. For trial software, freeware and other downloads, click the Install button below the product description, or follow the onscreen instructions (please make sure to read these carefully).

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Amazon Echo Hub

A simple way to control your smart home, but it's best suited to existing Ring customers

SCORE ★★★★★

PRICE £142 (£170 inc VAT)
from amazon.co.uk

When you can buy the third-gen Echo Show 8 (see issue 352, p72) for £100 – a price it's frequently discounted to from £150 – you may wonder why anyone would buy the Echo Hub. After all, this loses the webcam of its sister product and includes lesser speakers. It is, pure and simple, a smart home controller.

In practice this means that, while the Echo Show will bombard you with ads and messages, the Hub is a passive touchscreen. It also brings support for Zigbee, Thread and Matter, so you should have no difficulty adding devices. They're grouped together, so you can access all your cameras, lights and speakers in one location. Or you can head straight to a room and see all the associated devices located there. It's all logical, which makes sense as you want every member of your household to be able to use the Hub.

I also have good news for users of Honeywell's Evohome smart heating system. With the EvoControl Smart Heat widget – widgets are equivalent to apps and easy to install direct from the Echo Hub – you can jump to rooms and adjust temperatures directly. However, if your chosen system doesn't have a widget then you may be limited to a view-only approach rather than being able to take control from the Hub. And right now, the number of smart home widgets available in the UK that aren't made

by Amazon number precisely two: one for Evohome, one for Loop.

If you happen to own the Ring Alarm system then you can use the Hub to control this – but that's it for security systems. Perhaps this will change over time, but for now you can view, say, Netgear Arlo camera feeds but that's it. And other features only work with Ring hardware, such as the ability to display snaps from cameras. You need an active subscription, too, and as Barry Collins points out this month (see p22) that's not as cheap as it used to be.

Then we come to the hardware. It's basic (just look at those bezels), and chunky at 15mm thick. Nor does Amazon fit a top-end processor, choosing instead MediaTek's MT8169A chip. I still expected this to cope easily with the minimalist OS, and perhaps software updates will make the experience smoother, but right now it glitches even when you're scrolling in the Home screen.

Thankfully, the hardware is more than capable of playing video smoothly. That includes Amazon's Prime service, which is on call via a

ABOVE The Echo Hub lets you access all your smart home kit in one place



ABOVE The hardware is basic and chunky

"I love the proximity sensor. Approach the Echo Hub and the clock dissolves from view to be replaced by the homescreen"

swipe-down menu. YouTube and Netflix are viewable via the Silk browser; its buttons are tiny on the 8in, 1,280 x 800 screen, but it's usable.

Curiously, Amazon doesn't list a speaker in the Echo Hub's specs, but there is one – and considering the size of the device it's strong. I wouldn't choose it to listen to a violin concerto, but if all you want is to listen to the radio or have a quick blast of Taylor Swift then it does the job well.

There are some neat touches, too. The Hub is designed to be wall-mounted (although you can buy it with a stand for £195), and Amazon provides a cutout in the rear of the chassis for you to curl the supplied USB-C cable to the right length. Typically it consumes around 4W of power – at most around 7W – so isn't the most demanding of devices, which means you could feed it with a battery

pack for days at a time. There's no battery inside, though, so it needs a constant feed.

I also love the proximity sensor. Approach the Echo Hub and the clock – its default

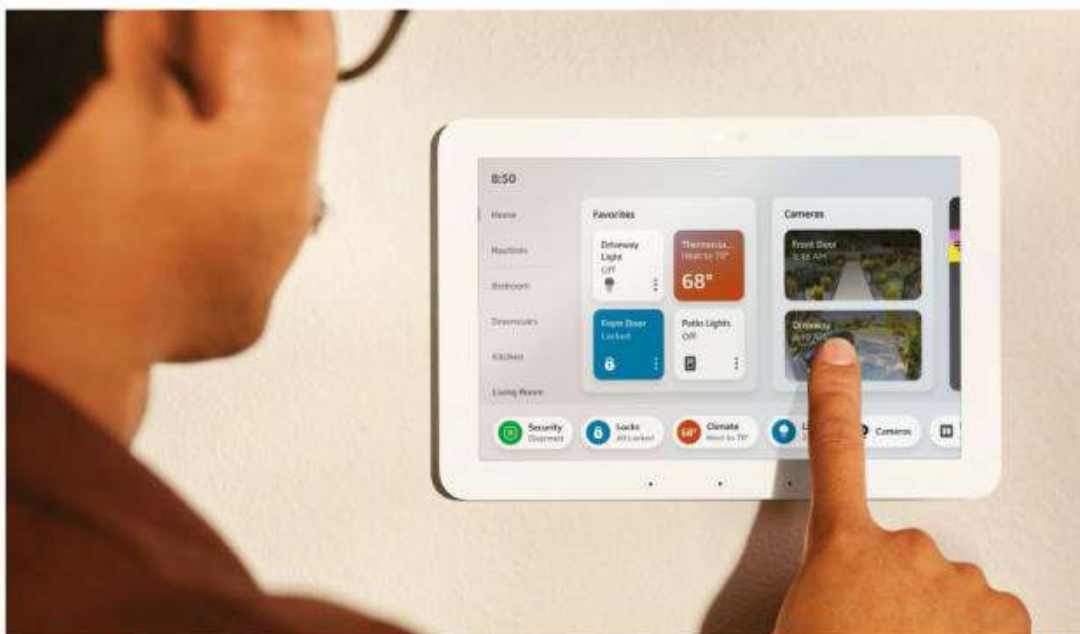
view when idle – dissolves from view to be replaced by the homescreen. The ambient light sensor also does an excellent job of ensuring the screen is visible in brighter conditions.

There is potential here, but I'd only recommend the Echo Hub to people who are already heavily invested in Ring products. **TIM DANTON**

SPECIFICATIONS

8in 1,280 x 800 touchscreen • 8-core MediaTek MT8169A SoC • Wi-Fi 5 • Bluetooth A2DP support • supports Zigbee, Thread and Matter • proximity sensor • ambient light sensor • 3 x mics • speaker • custom OS • 202 x 15 x 137mm (WDH) • 365g • 1yr warranty

ABOVE It's designed to be wall-mounted for easy access



Bag a software bargain

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Norton 360 Premium for £19.99 (10 devices for two years)

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Norton is one of the most trusted security brands around, and rightly so: it consistently earns 100% protection ratings from both AV-Comparatives and AV-Test. Norton 360 Premium is a comprehensive selection of tools designed to give you security and peace of mind.

First up is Norton Security, which offers strong anti-malware protection to monitor files and programs – not just for known threats, but for suspicious behaviour, too. This helps block malware before it can gain a foothold on your system. You also get a firewall, silently blocking attacks from both outside and inside your PC. Web Safety components check the links you click to make sure they're safe to visit, while downloaded files are screened and checked for both security and reliability.

Norton 360 bundles Secure VPN, which lets you browse anonymously wherever you are, block ad trackers and get "bank-grade encryption". You can

use your VPN to locate yourself in another country, which is good for watching TV while abroad, or simply to create a secure tunnel to the internet to stop hackers finding your real location and IP address.

Dark Web Monitoring will keep an eye on your data, such as email addresses and passwords, then check to see if this has been compromised online. If it has, it will warn you and you can quickly update your passwords.

Then there's a whopping 75GB of cloud storage for backups, plus Norton Parental Control so you see exactly what your children are up to on their various devices. You also get GPS location monitoring for Android and iOS and content filtering for PCs.

Finally, Norton Password Manager generates and stores passwords across all your devices, while SafeCam for PC stops cybercriminals attempting to take photos with your webcam with you knowing.



SAVE 89%

ALSO CONSIDER Avast Ultimate Suite 2024 (10 devices/2yrs) for £29.99 **SAVE 85%**

Upgrade to Windows 11 Pro for just £49.99

tinyurl.com/pcprowin11

If you're using Windows 11 Home but fancy switching to Professional, we have great news. Not only is it a steal at £49.99, but it's incredibly simple to do. Upgrading is a matter of typing "Change product key" and then entering your new Pro licence key into the dialog box. Windows will then update and reboot, and you'll see a fully activated Windows 11 Pro.

Within minutes, you'll have access to extra business functionality: enhanced BitLocker encryption, remote logins and more. Perhaps best of all, you can create and host virtual machines using Hyper-V, which is ideal for testing new software or, if you're a developer, checking how your software performs on other OSes.

Windows 11 Pro also enables you to quickly connect to a domain – this could be your business or a school – to access network files, servers and printers. It's ideal for taking your work on the road when you still need access to the office network.



SAVE 58%

ALSO CONSIDER Windows 10 Home (full, OEM) for £49.99 **SAVE 58%**

Bitdefender Total Security 2024 for £29.99 (5 devices for one year)

tinyurl.com/pcprobit24

Bitdefender Total Security 2024 is the company's full-strength, no-compromise security suite, and it won a Recommended award in our recent Labs (see issue 355, p84). We like it because it's reliable, effective, doesn't hog resources and it never bothers you with nags or questions.

If you were to buy direct from Bitdefender, Total Security costs £74.99. However, we've negotiated this £29.99 deal, covering five devices for a year, and you don't get hit by auto-renewals!

Aside from its security, we like the online management portal, where you can monitor the status of devices associated with your account – and find them if they're lost or stolen. Then there's the Total Security VPN, which offers a wide range of endpoint locations. And despite numerous features, the interface is easy to use. For example, head to the dedicated Ransomware Remediation module that creates a local backup of files when it detects an untrusted program trying to access them.



SAVE 60%

ALSO CONSIDER Auslogics File Recovery for £12.95 **SAVE 35%**

Kobo Libra Colour

A-great value colour ebook reader with full writing features, and the £70 stylus is well worth buying

SCORE ★★★★★

PRICE £167 (£200 inc VAT)
from uk.kobobooks.com

I've admired Kobo's Libra line of e-readers since the first was launched in 2019, but the new Libra Colour has two big upgrades over the previous Libra 2 model. The most obvious is a colour screen, but it also brings note-taking capabilities from Kobo's line of digital notebooks, expanding it from a passive reading device into a versatile companion for productivity and reference.

At £200 inc VAT, in your choice of black or white casing, it's cheap by the standards of digital notebooks – Amazon's monochrome Kindle Scribe is £275, while the Onyx Boox Tab Mini C costs £450. However, the price doesn't include a stylus, so to take full advantage of its new features you'll need to spend £70 on the Kobo Stylus 2. It charges via USB, so at least there are no ongoing battery costs to worry about.

Design-wise, the Libra Colour looks almost identical to the Libra 2. It's a highly ergonomic design: easy to hold in one hand, with a chunky bezel on one side and two page-turn buttons placed perfectly for comfortable access. The textured back panel helps you grip it securely – the white version I tried didn't pick up fingerprints at all – while a magnetic edge holds the stylus firmly to the opposite side. The whole thing weighs only 200g, and is made from 80% recycled materials.

The screen is an E Ink Kaleido 3 display, so its 4,096-colour palette isn't as rich as a tablet or laptop screen, but it has solid contrast with an effective resolution of 150ppi for colour content and 300ppi for monochrome text. Kobo's ComfortLight Pro technology automatically adjusts the colour balance from cool to warmer tones as the day progresses, and the Libra Colour also offers a



dark mode, showing ebook content in white text on a black background.

The Libra Colour uses the same clean, intuitive user interface as previous Kobo readers.

The only major change is the addition of the My Notebooks tab, which opens up Kobo's full suite of writing features. From here you can draw and write notes in a wide spectrum of colours, and adjust the type of pen, the thickness of the nib and more.

I have only two minor gripes about the Kobo Colour writing experience. One is that writing on a 7in screen can feel cramped, but you'll acclimatise to that quite quickly. The other is that the plastic screen coating is smooth, with no real friction as the stylus moves across it. I prefer a more physical, tactile response when I write, but again it's something you'll get used to.

ABOVE The ability to make notes turns the Libra Colour into a full productivity device



LEFT You'll have to pay an extra £70 for the Kobo Stylus 2

“You can draw and write notes in a wide spectrum of colours, and adjust the type of pen, the thickness of the nib and more”

For traditional e-reader duties the Kobo Colour is as flexible as you could ask for. There's 32GB of onboard storage, and getting material onto the device is made easy by integrations with Dropbox and Google Drive. The device also works with the Pocket browser plugin, so you can save online articles from a phone or laptop to read on your Kobo. There's native support for EPUB files, along with many other text and image formats, and audiobooks can be downloaded from the Kobo Store. The device won't play other audio files, however, and as always any books you've bought on Kindle will need to be converted via unofficial means before you can transfer them to the Kobo.

Annoyingly, there's a lag when you open an ebook from the home screen or My Books, which can leave you waiting for up to ten seconds before something happens. The Home button on the top left corner of a page also takes a few seconds to take effect; hopefully these issues will be fixed via a firmware update.

Otherwise, everything is slick. There's no lag when turning pages or when writing and drawing in your notebooks. Handwriting recognition (available via the “Advanced Notebooks” feature) is responsive, too, and accuracy almost unerring. Several colleagues also tested it with their scribbles, and it produced a near perfect transcription every time.

The 2,050mAh battery inside the Libra Colour gave me about 14 hours of use, which depending on your usage could easily translate to several weeks of on-and-off usage. I started testing the device straight out of the box at 82% battery life and it was still showing 19% two weeks later. Topping up via the USB-C port is quick: it took the Libra Colour 55 minutes to go from 19% to 96%, though trickle

charging then kicks in to preserve battery health, so hitting 100% took another 45 minutes.

In all I'm a big fan of the Kobo Libra Colour, especially with the stylus. It's a great colour

e-reader, and a likeable and intuitive note-taking device, for a competitive price. **SHARMISHTA SARKAR**

SPECIFICATIONS

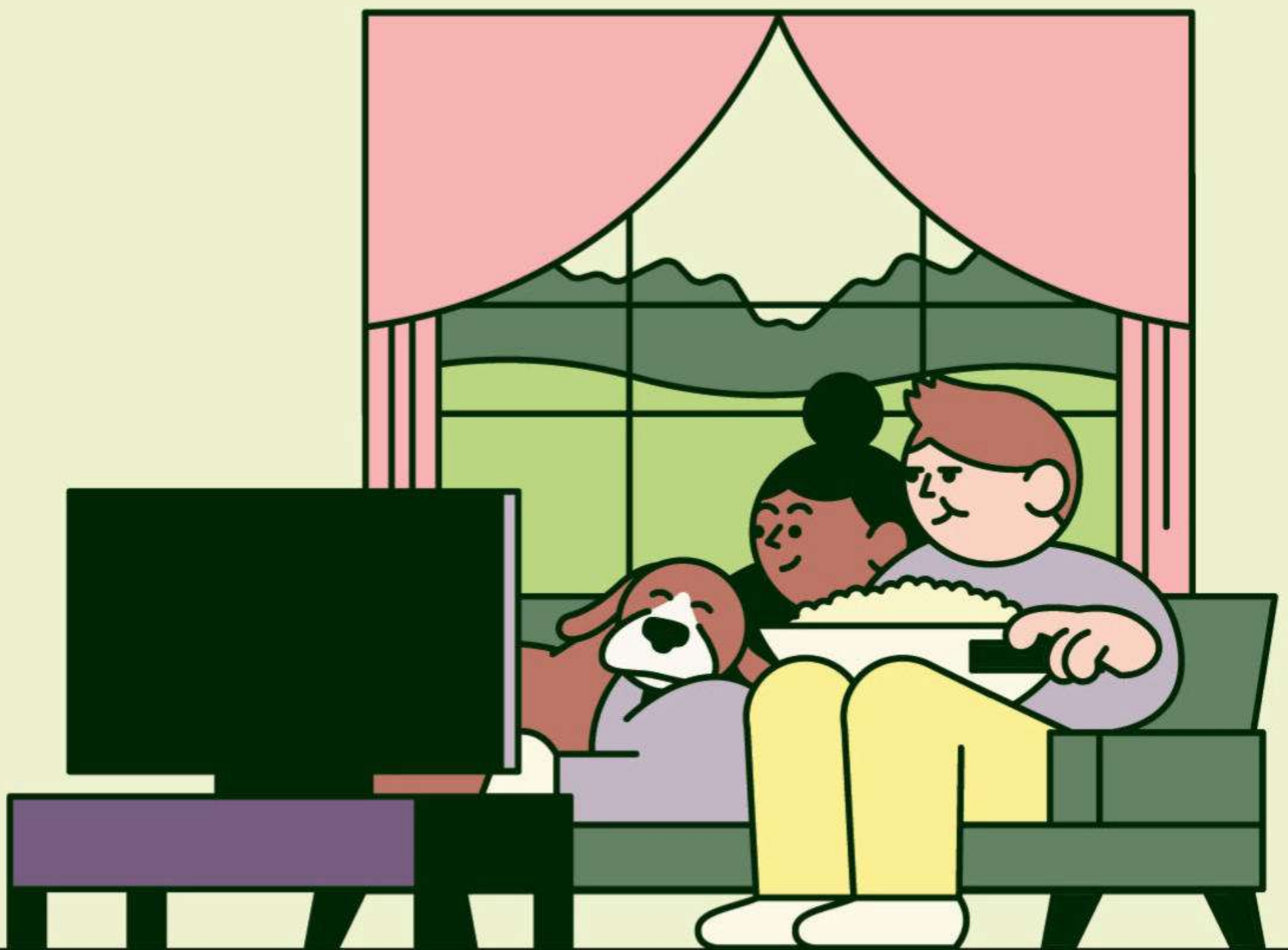
7in E Ink Kaleido 3 screen • 300ppi black and white • 150ppi colour • 1,264 x 1,680 resolution • 32GB storage • Wi-Fi 4 • Bluetooth • USB-C • IPX8 protection • 2,040mAh battery • supports Kobo audiobooks, EPUB, EPUB3, PDF and 12 more file formats • 145 x 8.3 x 161mm (WDH) • 200g • 1yr limited warranty

LEFT The textured back panel helps you grip the Kobo securely



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Labsmini

PORTABLE SSDs

FROM £69

We review 12 portable SSDs that cover a wide range of standards, form factors and target users

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Before you buy a portable SSD, you should consider several factors. Most obviously, speed. While they all use USB-C ports, there's a huge difference in transfer rates, with two factors in play: one is the chips and electronics inside the drive, and the other is the standard supported by the connector. The fastest drives all support USB 3.2 Gen 2x2, with its 20Gbits/sec bandwidth, but that's only of use if the device you're connecting it to also supports that standard (or USB 4, which is backwards-compatible). Most don't, so you could end up wasting money.

Then there's how much storage you actually need. Generally, we'd play safe. If you think you can "get away" with 500GB, go for 1TB. The same is true if you think 1TB should be just about enough; it won't be.

You also need to think about how big the drive is physically. Some portable SSDs are

little bigger than a USB thumb drive, while others barely fit in a pocket. Match the size to the target device you'll be connecting it to; for example, if it's just going to sit next to a PC then who cares, but if you're going to use it to add extra storage to your camera while on a photo shoot, then compactness rules.

It's also worth considering the software package and the warranty. All the drives here come with a minimum three years of cover, but for extra peace of mind why not choose a drive that offers more – especially if the price difference is minimal.

The good news is that all the drives we've included here are fine choices, even if not all of them earn five-star ratings. We're confident that one of them will fit your needs perfectly.

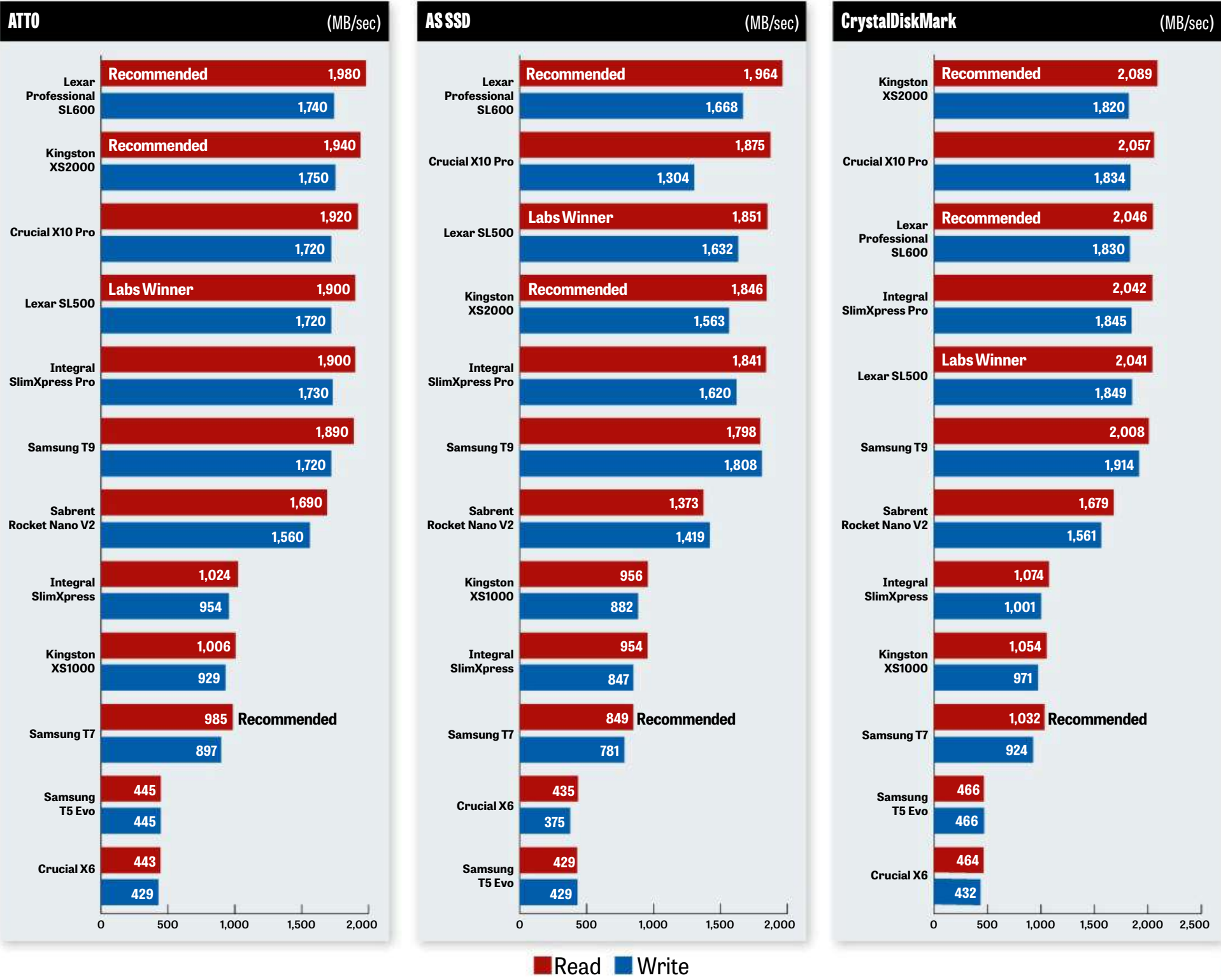
CONTRIBUTORS: Desire Athrow, Tim Danton, Alistair Jennings, Mark Pickavance, Sean Webster



					RECOMMENDED		RECOMMENDED	LABS WINNER			RECOMMENDED	
	Crucial X6	Crucial X10 Pro	Integral SlimXpress	Integral SlimXpress Pro	Kingston XS1000	Kingston XS2000	Lexar Professional SL600	Lexar SL500	Sabrent Rocket Nano V2	Samsung T5 Evo	Samsung T7	Samsung T9
Overall rating												
Price (inc VAT)*	1TB, £58 (£69 inc VAT)	1TB, £91 (£109 inc VAT)	1TB, £72 (£86 inc VAT)	1TB, £83 (£99 inc VAT)	1TB, £65 (£78 inc VAT)	1TB, £88 (£106 inc VAT)	1TB, \$130	1TB, £85 (£102 inc VAT)	1TB, £86 (£103 inc VAT)	2TB, £133 (£160 inc VAT)	1TB, £78 (£93 inc VAT)	1TB, £102 (£122 inc VAT)
Supplier	uk.crucial.com	uk.crucial.com	ballicom.co.uk	amazon.co.uk	kingston.com	amazon.co.uk	amazon.com	amazon.co.uk	amazon.co.uk	argos.co.uk	amazon.co.uk	scan.co.uk
Capacities	500GB, 1TB, 2TB, 4TB	1TB, 2TB, 4TB	500GB, 1TB, 2TB, 4TB	500GB, 1TB, 2TB, 4TB	1TB, 2TB	500GB, 1TB, 2TB, 4TB	512GB, 1TB, 2TB	512GB, 1TB, 2TB, 4TB	1TB, 2TB, 4TB	2TB, 4TB, 8TB	500GB, 1TB, 2TB	1TB, 2TB, 4TB
USB-C support	3.2 Gen 2	3.2 Gen 2x2	3.2 Gen 2	3.2 Gen 2x2	3.2 Gen 2	3.2 Gen 2x2	3.2 Gen 2x2	3.2 Gen 2x2	3.2 Gen 2x2	3.2 Gen 1	3.2 Gen 2x2	3.2 Gen 2x2
USB-C max speed	10Gbits/sec	20Gbits/sec	10Gbits/sec	20Gbits/sec	10Gbits/sec	20Gbits/sec	20Gbits/sec	20Gbits/sec	20Gbits/sec	5Gbits/sec	20Gbits/sec	20Gbits/sec
Claimed read speed	800MB/sec	2,100MB/sec	1,050MB/sec	2,000MB/sec	1,050MB/sec	2,000MB/sec	2,000MB/sec	2,000MB/sec	1,500MB/sec	460MB/sec	1,050MB/sec	2,000MB/sec
Claimed write speed	No claim made	2,000MB/sec	1,000MB/sec	2,000MB/sec	1,050MB/sec	2,000MB/sec	2,000MB/sec	1,800MB/sec	1,500MB/sec	460MB/sec	1,000MB/sec	2,000MB/sec
Dimensions (WDH)	69 x 64 x 11mm	65 x 50 x 10mm	32 x 106 x 9mm	34 x 74 x 7mm	33 x 70 x 13.5mm	70 x 33 x 13.5mm	59 x 113 x 10.6mm	53 x 85 x 7.8mm	30 x 70 x 11.9mm	40 x 95 x 17mm	57 x 85 x 8mm	60 x 88 x 14mm
Weight	39g	42g	43g	28g	29g	29g	64g	43g	46g	102g	58g	122g
Encryption	✗	256-bit AES	✗	✗	✗	✗	256-bit AES	256-bit AES	✗	256-bit AES	256-bit AES	256-bit AES
Warranty	3yr	5yr	4yr	4yr	5yr	5yr	5yr	5yr	3yr	3yr	3yr	5yr
Other	✗	Crucial Storage Executive software, IP55 rated	✗	✗	✗	IP55 rated	Lexar DataShield software	Lexar DataShield software	✗	2m drop resistance, Samsung Magician software	Samsung Magician software	3m drop resistance, Samsung Magician software

*All prices are correct at time of going to press

Sequential transfer speed tests





Crucial X6

Not the speediest or most stylish, but it's compact and lower capacities are great value

SCORE ★★★★★

PRICE 1TB, £58 (£69 inc VAT)
from uk.crucial.com

READ 447MB/sec
WRITE 412MB/sec

The first thing you notice about the Crucial X6 is how small it is; not far off USB thumb drive size (69 x 64 x 11mm). The second thing is its price, which is among the lowest in this test. A fact reflected by its minimalist black plastic case, adorned only by the Crucial logo.

But more crucially, if you'll forgive the terrible pun, the price is reflected by its speed. Crucial promises read speeds of up to 540MB/sec over its USB-C 3.2 Gen 2 connection, but it failed to reach even this modest target. An average of 447MB/sec reads and 412MB/sec writes across our tests means you'll be left waiting for big files to copy across – a 10GB file took 33 seconds to copy. And that was with a 2TB version of the Crucial X6; if you opt for a smaller capacity, which has fewer chips inside, it will take longer. (Larger drives can write to several NAND chips at the same time, speeding up the read/write process.)

At least Crucial offers a solid range of capacities, with the 500GB version costing £53, 2TB £101 and 4TB £204. All those prices are direct from Crucial and are tagged as a "deal" as they're a big discount from the original cost – but this drive is now three years old so we would expect a price drop.

You don't get many extras here. No USB-C to USB-A cable, only USB-C to USB-C, and there's no extra software or hardware encryption, either. Nor do you get any promises about drop resistance, while the three-year warranty is relatively modest. Still, what do you expect for the price? It's a back-to-basics model in every conceivable way – and, unlike the Samsung T5 Evo, it is at least available in cheaper, smaller capacities than 2TB.



Crucial X10 Pro

Pricy, but this attractive SSD has some nice features – and the X9 Pro is worth considering, too

SCORE ★★★★★

PRICE 1TB, £91 (£109 inc VAT)
from uk.crucial.com

READ 1,951MB/sec
WRITE 1,619MB/sec

The X10 Pro is one of this month's top-end drives thanks to its support for USB-C 3.2 Gen 2x2 ports. That's great if you have them, or USB 4, but if not then your read and write speeds will roughly halve from our chart-topping results. The X9 Pro, not on test here, is the same hardware but it maxes out at USB 3.2 Gen 2 speeds and is slightly cheaper.

In terms of size, the X10 Pro is a fraction smaller than the X6, and that means it's extremely pocketable. The top is a solid block of aluminium milled inside to make room for the SSD, while the underside has a rubberised finish that prevents it from sliding around. It also stops dust and water to IP55 standards, so think light rain rather than a 50m swim. It's specified to withstand a drop of 2m, but only on a carpeted floor, not concrete. Surely all drives can survive a 2m drop onto carpet?

It's a nice design, with one oddity: a hole in the top-right corner. You could use this to hang it on a lanyard, but that would block the activity LED – and this can only be seen from acute angles anyway.

Crucial bundles one, short USB-C cable (23cm), which is stingy for the price – especially if you opt for the 2TB version at £187, or the 4TB model for £291. There is at least some full software here, with Crucial Storage Executive designed to manage and maintain SSDs. It also provided a firmware update for the drive. Note that there's hardware encryption here, too.

If you don't need USB-C 3.2 Gen 2x2 support then consider the X9 Pro, which is significantly cheaper: £83 for 1TB, £144 for 2TB and £248 for 4TB. If you do, we think the Lexar SL500 just has the edge.



Integral SlimXpress

An extremely compact drive with good speeds for its class, and we can't argue with the price

SCORE ★★★★★

PRICE 1TB, £72 (£86 inc VAT)
from ballicom.co.uk

READ 1,017MB/sec
WRITE 934MB/sec

Integral Memory may not be a household name in the global storage market, but this British company has carved a niche in the UK. The similarity of the SlimXpress's design with those by Netac lead us to believe they share the same original design manufacturer (ODM), which means Integral must mark itself out from such rivals with customer support, warranty and price.

The 1TB version is certainly good value, although we're less impressed by £59 for the 500GB version and £291 for 4TB. The warranty is strong at four years, while Integral promises that its 30 years in the industry mean you can trust it as a brand. If nothing else, you can storm its London HQ – and there's actually a phone number to call.

In terms of design, a slim, flat aluminium chassis protects the precious components within and acts as a heatsink – expect the drive to become warm with extensive use. It's little bigger than a pack of chewing gum and also light at 43g, meaning it rivals a thumb drive for portability – except that you still need to plug in a cable. Integral provides a USB-A adapter to go along with the short USB-C to USB-C cable, with the port sitting at one narrow end and the capacity stamped on the other.

That port is rated at USB 3.2 Gen 2 and the Integral SlimXpress performed at the expected speeds. Its best result came in CrystalDiskMark, where it topped the list of similarly specified drives.

With no bundled software and no hardware encryption, there's a back-to-basics feel about this drive. But if you want to support a British company and don't need anything fancy, it's a fine choice.



Integral SlimXpress Pro

The lightest USB-C 3.2 Gen 2x2 on test, and it's incredibly compact too – and the price is great

SCORE ★★★★★

PRICE 1TB, £83 (£99 inc VAT)
from amazon.co.uk

READ 1,931MB/sec
WRITE 1,732MB/sec

It may be only by one gram, but the SlimXpress Pro can claim to be the lightest USB-C 3.2 Gen 2x2 drive on test. Integral, a British company, claims read and write speeds of 2,000MB/sec, and it came close to the former in our tests.

In real-world use, when we connected it to a PS5, the Pro's high transfer speeds and large capacity made it easy to store numerous games and data. It also worked well with a Blackmagic 6K camera, directly storing 6K raw files, and with an iPhone 15 Pro for Apple ProRes files. Additionally, its small size and light weight made it an ideal choice when we were looking for a media store to connect to a smart TV.

Design-wise, the Pro is as compact as you'd expect for its weight, featuring a slim metal case that's durable and ultra-portable. As with its sibling, the metal draws heat away from the components, and while the SlimXpress Pro does get warm with extended use, we found no sign of performance dropping over time: it copied 370GB of mixed files in about five minutes.

The "Pro" in this drive's name doesn't allude to bundled software or encryption. It's a plain and simple drive, just like the standard SlimXpress. But it does come with a four-year warranty (or 3,000 terabytes written, whichever comes first).

As ever, you'll need a PC that can take advantage of the higher USB rating, or it's not worth spending the extra over a lesser-specified drive. Not that £99 is a bad price for 1TB of storage, and it compares well with 2x2 rivals. If you're on a tight budget, it's great choice. If not, consider the Lexar SL500 – which does come with extras – before buying the SlimXpress Pro.



Kingston XS1000

While it lacks frills, this pocket-friendly drive's killer selling point is its price

SCORE ★★★★★

PRICE 1TB, £65 (£78 inc VAT)
from kingston.com

READ 1,005MB/sec
WRITE 927MB/sec

Arriving 18 months after the XS2000, there are only two real differences to note between the drives: that the XS1000 comes in black and that it uses the USB-C 3.2 Gen 2 standard rather than the XS2000's Gen 2x2. That limits bandwidth to 10Gbits/sec rather than 20Gbits/sec, which is why its results are roughly half those of its sibling. However, as always, this only matters if you'll be transferring data over a USB-C 4 or USB-C 3.2 Gen 2x2 port, and both remain rare.

Actually, there are three other differences between the drives, too. First, the XS1000 is only available in 1TB and 2TB capacities. Second, it's significantly cheaper, at £78 versus £106 for the smaller capacity and £124 rather than £182 if you prefer to have 2TB of storage. And third, there's no rubber sleeve to add extra protection from knocks, and no mention of IP55 ratings.

Being only 7cm long and 29g, the XS1000 is remarkably easy to shove in a pocket; easier than the supplied USB-C to USB-A cable (there's no USB-C to USB-C cable in the box). And its results were strong for the Gen 2 standard, battling it out with the Integral SlimXpress for the top slot (within this category) and emerging with excellent average read speeds of 1,005MB/sec across our three tests.

Where it falls behind rivals such as the Samsung T7 is the "value add". There's no extra software here and no hardware encryption, so its only bonus selling point is the five-year warranty. But what truly separates the XS1000 from others, including its sibling, is its price. And that's what wins it five stars and an award.



Kingston XS2000

A supremely fast drive that's compact and well built, but don't expect extra features

SCORE ★★★★★

PRICE 1TB, £88 (£106 inc VAT)
from amazon.co.uk

READ 1,958MB/sec
WRITE 1,711MB/sec

Many larger portable SSDs include an adapter board to connect the NVMe SSD to the USB interface, but Kingston's XS2000 includes a streamlined internal design to reduce the size, weight, power consumption and cost. That's also true for the XS1000, but here Kingston employs USB-C 3.2 Gen 2x2, which has double the bandwidth of Gen 2 found in its sibling – and that's why it proved twice as fast.

Inside the box, you'll find an 11.5in cable that's USB-C to USB-C rather than the USB-C to USB-A bundled with the XS1000, plus a rubber sleeve. Use this and Kingston promises IP55 protection against water and dust, and while that's welcome we have previously tested portable SSDs such as the SanDisk Extreme Pro (see issue 324, p84) that are truly rugged, rather than merely being "built for durability" with the promise of being shockproof. At least the XS2000 comes with a five-year warranty.

If you look closely you'll spot a blue LED light next to the drive's USB-C port, but otherwise this is a nondescript plastic and metal device finished in grey. It actually looks more attractive with the rubber sleeve to add contrast, and this barely adds to its dimensions. For make no mistake, this is a very compact drive, just like its sibling.

With excellent scores throughout our tests – including loading *Final Fantasy XIV* in 13.45 seconds, the second fastest time we've seen – there's no doubt you're getting a supremely fast drive if you buy the XS2000. However, others here offer hardware encryption and useful software for a little extra expense, so only choose it if compactness is your priority.



Lexar Professional SL600

A superb all-round package thanks to its speed and software bundle, but it's US only for now

SCORE ★★★★★

PRICE 1TB, \$130 (exc local sales tax)
from amazon.com

READ	1,997MB/sec
WRITE	1,746MB/sec

Unlike many portable SSDs that shove Pro into their name, the Lexar Professional SL600 is genuinely aimed at professionals – primarily photographers and videographers. This 64g device, complete with handy carabiner loop at the top, has an all-metal casing that's larger than rivals such as the Kingston XS2000 but should make it difficult to lose.

It's still sleek enough to slip into a pocket, but we wonder if Lexar should have opted for a brighter colour finish to help photographers find it quickly in their kit bags. At the other extreme, for those looking for extra storage for a desk-based computer, the flat design makes it easy to add Velcro and then attach to a monitor.

Only a USB-C connector interrupts the SL600's design, and once connected you can install the supplied Lexar DataShield software within seconds. You can then apply password protection, just in case you do misplace the drive, with 256-bit AES encryption on hand.

With support for USB-C 3.2 Gen 2x2, it can reach over 2,000MB/sec transfer speeds over the right connections. You won't need to look at the graphs on p73 for long to see the effect of this, with the SL600 proving the fastest here for sequential reads, though the Samsung T9 takes the lead for writes.

With a five-year warranty, the only concern we have is around availability. It was only released this year and units remain limited in the US, while the company is yet to commit to a UK launch date. Despite this, its quality and speed means that it's one of the most compelling Gen 2x2 drives on test – and worth seeking out if you're visiting the States.



Lexar SL500

Photographers who need a drive to extend a phone or camera's storage will find much to love

SCORE ★★★★★

PRICE 1TB, £85 (£102 inc VAT)
from amazon.co.uk

READ	1,928MB/sec
WRITE	1,732MB/sec

The Lexar SL500, like the SL600, is part of a new generation of ultra-slim portable SSDs aimed at professionals needing to travel light while capturing and editing images and videos on the move.

The SL500's key selling point is a lightweight design coupled with a stylish but reassuringly tough metal casing. This makes it an excellent semi-permanent complement to cameras that need extra storage. It can also be linked to the iPhone 15 Pro and Max and used to store Apple Pro Res recordings at up to 4K at 60fps.

Transfer speeds to and from a computer will depend on the connector. This is a USB-C 3.2 Gen 2x2 SSD, with the promise of 2,000MB/sec reads and 1,800MB/sec writes, and that's what we saw on a suitable laptop. With a MacBook, however, it defaulted to USB-C 3.2 Gen 2 speeds, averaging 978MB/sec reads and 890MB/sec writes. You'll see the same pattern with all such drives.

We're not sure this makes a huge difference for the target market. We had no problems when handling large files from cameras such as the Canon R5 C and Sony A7 IV when performing image-editing tasks in Photoshop, nor in demanding video-editing scenarios with Final Cut Pro X.

We also like the SL500's price, with the 1TB version costing £102 on Amazon and the 2TB option £176. However, echoing our problems sourcing the SL600, we couldn't find the 512GB or 4TB models for sale. Still, if you're happy with those capacities then the price is extremely competitive for a USB-C 3.2 Gen 2x2 drive, especially when you factor in 256-bit AES encryption and a five-year warranty.



Sabrent Rocket Nano V2

Too expensive when you consider its speed and features, despite its nano dimensions

SCORE ★★★☆☆

PRICE 1TB, £86 (£103 inc VAT)
from amazon.co.uk

READ	1,581MB/sec
WRITE	1,513MB/sec

The Rocket Nano V2 is a curious drive. Sabrent obviously spent considerable time and effort constructing a robust enclosure, even bundling a silicon bumper you can wrap around its aluminium shell for added protection. But it makes no claims about fall survival heights or if this keeps water and dust out.

The bumper has strategically cut holes that show the Rocket logo and an activity light, and slots that we presume are for heat dissipation. With the bumper in place, the Nano V2 feels like it should withstand plenty of abuse, so it's a shame it comes with a mediocre three-year warranty.

Another curiosity is that this is a USB 3.2 Gen 2x2 drive but its claimed speeds are 1,500MB/sec for both reads and writes, rather than the 2,000MB/sec we see from rivals. Our tests suggest Sabrent is under-selling its read skills, but if speed is your priority this still isn't your best choice. There's no hardware encryption, either.

Nor is it a star if you're looking for software, with no bundled utilities; not even a way to update the firmware. In fact, the only sign of generosity here is that Sabrent includes two cables rather than one – USB-C to USB-A and USB-C to USB-C – and the metal box that the Nano V2 ships in doubles as a transport/storage box.

If it weren't for the Kingston XS2000, Sabrent could argue that the Nano's size counts in its favour – for it is indeed a compact drive. But unless you can find it significantly cheaper in your choice of size – and we couldn't, with the 2TB version costing £185 and the 4TB £390 – we see no reason to choose the Rocket Nano V2 over our award winners.



Samsung T5 Evo

Slow and heavy, the T5 Evo is only worth considering if you require 8TB of mobile storage

SCORE ★★★★★

PRICE 2TB, £133 (£160 inc VAT)
from argos.co.uk

READ 447MB/sec
WRITE 447MB/sec

Eight terabytes. Support for that huge capacity is what marks the Samsung T5 Evo Portable SSD out from all the others, even if it's also outsized physically at 17mm thick, 95mm long and 40mm wide. With a surprising 102g weight, you'll certainly notice it in a jeans pocket. Still, it's extremely well built thanks to a unibody aluminium enclosure wrapped in a rubber sleeve. That carry handle at the top could prove useful, too.

Despite its rugged looks, Samsung makes no claims about IP ratings or drop resistance. Nor does it add to its basic three-year warranty. At least you benefit from Samsung's Magician software, which eases data migration from a previous drive, adds hardware encryption and provides health checks and firmware updates. We like the 46cm USB-C to USB-C cable, too, but anyone stuck with USB-A ports will need to hunt out their own adapter.

This drive isn't designed for speed, using cheaper QLC NAND chips (rather than TLC) to boost storage volume without driving up the price to a ridiculously high point. This, and its USB-C 3.2 Gen 1 port, is why it's one of the slowest drives here; Samsung states read and write speeds of up to 460MB/sec, and give or take a few megabytes we saw close to that across all three tests.

With no 1TB version, the cheapest version of this drive – 2TB – costs £160 from online retailers. That's far more expensive than the Crucial X6 (£101), while asking £370 for the 4TB version is... let's say brave. With so much competition elsewhere, this drive only really makes sense if you desperately need 8TB of storage, and can stomach the £539 asking price.



Samsung T7

Close to drawing its pension, but this remains a solid and stylish choice – in red, at least

SCORE ★★★★★

PRICE 1TB, £78 (£93 inc VAT)
from amazon.co.uk

READ 955MB/sec
WRITE 867MB/sec

The Samsung T7 is one of the older drives here, having been released in 2020, but thanks to regular price cuts this USB-C 3.2 Gen 2 drive can still compete with the best. The 500GB model is no longer on sale from Samsung but you can buy it from Argos for £74, while we found the 1TB version on sale on Amazon for £93 and the 2TB edition for £155.

Hunt online and you can still find a Touch version of the T7, too – which includes a fingerprint reader for extra protection – but this comes at a premium of roughly £50. As does the ruggedised IP65-rated version of this drive, the T7 Shield.

On the inside, both of those variants are the same as the plain T7. Although “plain” isn't entirely fair, with the blue and red variants adding style to the compact aluminium shell. It's slim, at 8mm, and slips easily into a pocket.

There were no big surprises in our speed tests, but if you want to max out USB-C 3.2 Gen 2's 10Gbits/sec bandwidth then the Integral SlimXpress and Kingston XS1000 are better choices. The only way to get a notable boost, though, is to choose a USB-C 3.2 Gen 2x2 drive, assuming you have a suitably quick laptop or PC to connect to.

Samsung is more generous than most in terms of extras, with a pair of short USB-C to USB-C and USB-C to USB-A cables in the box. You also enjoy the benefits of Samsung's Magician SSD software (as is usual with Samsung drives), along with the company's standard three-year warranty.

We like this portable SSD's style, but with faster drives available for only a few pounds more the Samsung T7 no longer stands out from the crowd.



Samsung T9

It's tough to justify the price of this ruggedised, rubberised drive, but it's certainly fast

SCORE ★★★★★

PRICE 1TB, £102 (£122 inc VAT)
from scan.co.uk

READ 1,899MB/sec
WRITE 1,814MB/sec

Although it shares the same slim, rectangular design as the T7, the much more recent T9 differs from its sibling in two key ways. The first is that Samsung embraces the USB 3.2 Gen 2x2 standard, offering 20Gbits/sec compared to 10Gbits/sec for the plain Gen 2; the second is that it's coated with wavy rubber. This is bonded to the metal interior shell of the drive, so you can't remove it.

The rubber adds significantly to the thickness and weight of the drive, and while Samsung doesn't offer any IP ratings it does promise that it's drop-resistant to 3m (it makes no drop-resistance claims at all for the T7). For extra reassurance, Samsung also boosts its usual warranty from three years to five.

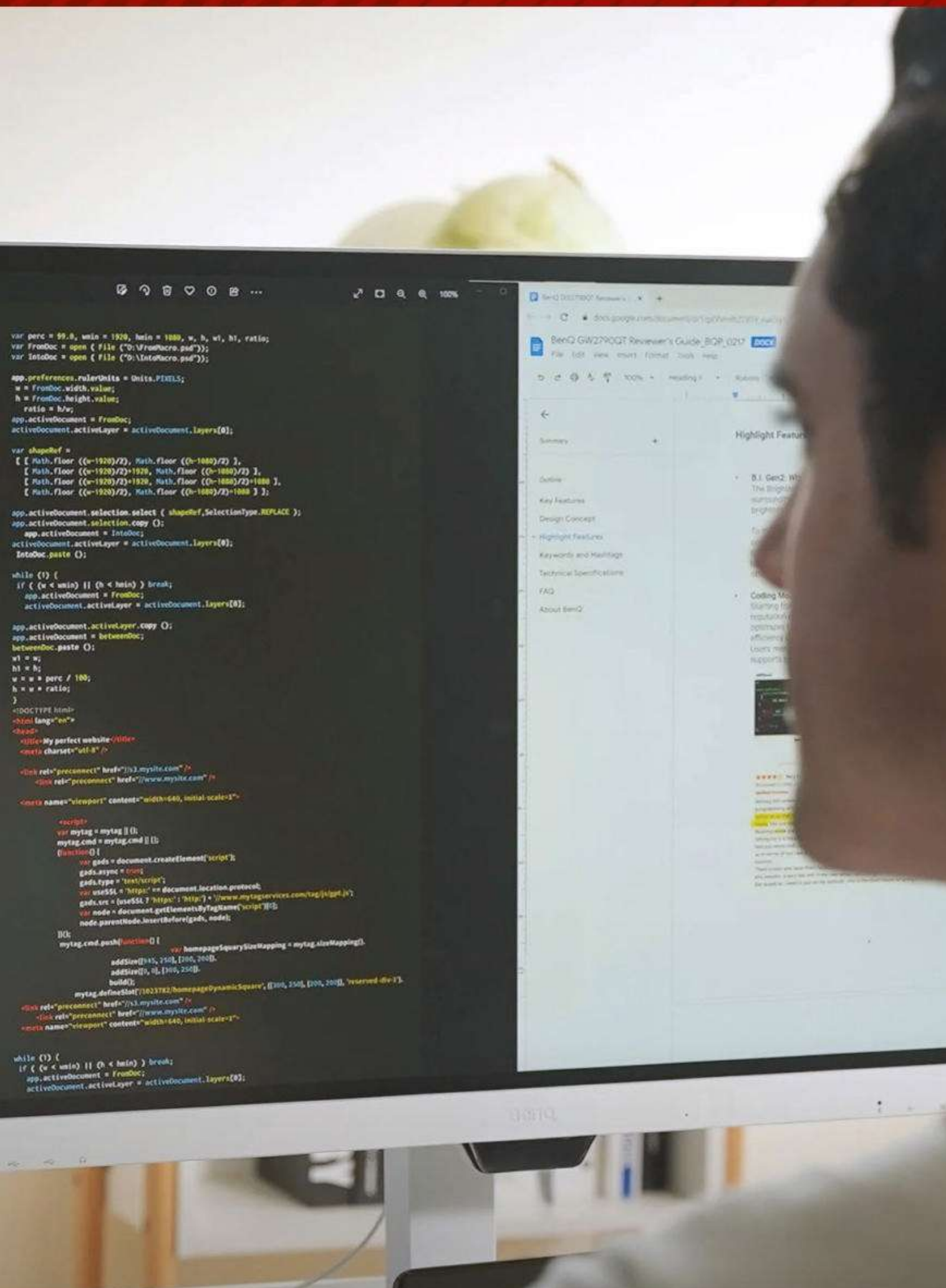
You also get 256-bit AES encryption via Samsung's Magician 8 software, complete with its usual mix of maintenance tools and data-migration features. But there's no backup tool, so don't get too excited.

In terms of speed, Samsung came in a consistent fourth place across our tests. There's no doubt the Lexar SL600 is faster, but whether you'll notice this in real-world use is an entirely different matter. And, as we never tire of pointing out, you need a USB-C port that supports Gen 2x2 or USB 4 anyway, or you'll see no difference compared to, say, the T7.

You can easily connect this drive to USB-A ports, too, as Samsung includes both cables in the box. This goes a tiny way to justify the premium the company is charging compared to rivals – the 2TB version costs £208, the 4TB model £383 – but only those prone to dropping SSDs should consider it. ●



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It's tempting to say that monitors come in all shapes and sizes, but that isn't quite true. You've probably already noticed that they tend to be rectangular. But the sizes generalisation does hold, which is why we had to lay down some ground rules for this test: a minimum size of 27in, a maximum of 34in. We've covered larger monitors in *PC Pro* recently, and will continue to do so, but we wanted to stay focused on the mainstream in this month's Labs.

That means we also steer clear of gaming monitors; we're quite happy to let others worry about ridiculous response times and refresh rates. And RGB. And headphone stands. As you'll see, however, a few monitors on test would make excellent companions during the working day before transforming

themselves into entertainment centres at night – the Samsung ViewFinity S9 in particular.

There are also a couple of monitors here with professional aspirations, including the BenQ PD2706U. While it can't match the Eizo ColorEdge CG2700X for its colour-switching skills or its built-in hardware calibration, it does have the advantage of being a sixth of its rival's price. Mind you, the only thing that the exceptional CG2700X can't do is display in 3D, as we discuss on p92.

Despite our attempts to make this a focused Labs, you'll find a huge amount of choice in terms of features, price and colour reproduction. Hopefully, our feature table, buyer's guide and comprehensive reviews will reveal which is perfect for your needs.

CONTRIBUTOR: Tim Danton

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	RECOMMENDED			RECOMMENDED	RECOMMENDED	RECOMMENDED	RECOMMENDED	
	Acer Vero B277 Ebmi przxv	Acer Vero CB272K bmiipr x	AOC 27B3CA2	AOC CU34P3CV	BenQ BL2790QT	BenQ PD2706U	Eizo ColorEdge CG2700X	
Overall rating								
Buying information								
Price	£124 (£149 inc VAT)	£224 (£269 inc VAT)	£125 (£150 inc VAT)	£317 (£380 inc VAT)	£225 (£270 inc VAT)	£333 (£399 inc VAT)	£2,149 (£2,579 inc VAT)	
Supplier	currys.co.uk	currys.co.uk	amazon.co.uk	amazon.co.uk	laptopsdirect.co.uk	scan.co.uk	wexphotovideo.com	
Part code	UM.HB7EE.E13	UM.HB2EE.039	27B3CA2	CU34P3CV	9H.LLLLA.TPE	9H.LLJLB.QBE	CG2700X-BK	
Service & support								
Warranty	3yr limited	3yr limited	3yr RTB	3yr RTB	3yr on-site swapout	3yr C&R	5yr on-site swapout	
Manufacturer's reliability ¹	92%	92%	92%	92%	96%	96%	N/A	
Overall brand satisfaction ¹	91%	91%	91%	91%	93%	93%	N/A	
EPEAT rating	Silver	Silver	Not yet rated	Silver	Bronze			
Display								
Panel size	27in	27in	27in	34in	27in	27in	27in	
Resolution	1,920 x 1,080	3,840 x 2,160	1,920 x 1,080	3,440 x 1,440	2,560 x 1,440	3,840 x 2,160	3,840 x 2,160	
Aspect ratio	16:9	16:9	16:9	21:9 (approx)	16:9	16:9	16:9	
Pixel density	81ppi	163ppi	81ppi	110ppi	109ppi	163ppi	163ppi	
Panel type	IPS	IPS	IPS	VA	IPS	IPS	IPS	
Curvature				1500R				
Backlight	W-LED	W-LED	W-LED	W-LED	W-LED	W-LED	W-LED	
Key specifications								
Peak brightness (stated)	250cd/m²	350cd/m²	250cd/m²	300cd/m²	350cd/m²	350cd/m²	500cd/m²	
Static contrast ratio (stated)	1,000:1	1,000:1	1,300:1	3,000:1	1,000:1	1,200:1	1,450:1	
Display colours	16.8 million	1.07 billion	16.8 million	16.8 million	16.8 million	1.07 billion	1.07 billion	
Colour depth	6-bit + FRC	8-bit + FRC	6-bit + FRC	8-bit	6-bit + FRC	8-bit + FRC	10-bit	
HDR claim/certification		HDR10				DisplayHDR 400		
Maximum frequency (vertical)	100Hz	60Hz	100Hz	100Hz	60Hz	60Hz	60Hz	
Claimed response time (G2G)	4ms	4ms	4ms	4ms	5ms	5ms	13ms	
AMD/Nvidia adaptive sync?	AMD FreeSync	AMD FreeSync	Adaptive sync mode					
Video inputs								
DisplayPort (version)	1 (1.2)	1 (1.2)		1 (1.4)	1 (1.2)	1 (1.4)	1 (1.2)	
HDMI (version)	1 (1.4)	2 (2.0)	1 (1.4)	1 (2.0)	1 (1.4)	1 (2.0)	1 (2.0)	
USB-C (power rating)			1 (65W)	1 (65W)	1 (65W)	1 (90W)	1 (92W)	
Other	VGA				DisplayPort out			
Ports & docking								
RJ45								
USB-C (power rating)					 (7.5W)	 (power not stated)		
USB-B								
USB-A hub	2 x USB-A 3.2 Gen 1 (5Gbits/sec)		2 x USB-A 3.2 Gen 1 (5Gbits/sec)	4 x USB-A 3.2 Gen 1 (5Gbits/sec)	3 x USB-A 3.2 Gen 1 (5Gbits/sec)	3 x USB-A 3.2 Gen 1 (5Gbits/sec)	2 x USB-A 3.2 Gen 1 (5Gbits/sec), 2 x USB-A 2	
Headphones socket								
Other	3.5mm input				3.5mm input, microphone			
Stand features								
Adjustable height	150mm	165mm		150mm	110mm	150mm	155mm	
Portrait mode								
Tilt angle (forward/back)	5°/35°	5°/35°	5°/23°	5°/23°	5°/20°	5°/30°	5°/35°	
Swivel angle (left/right)	45°/45°	178°/178°		175°/175°	20°/20°	20°/20°	172°/172°	
Other features								
Webcam								
KVM								
VESA mount								
Integrated power supply								
Speakers	2 x 2W	2 x 2W	2 x 2W	2 x 5W	2 x 2W	2 x 2.5W		
Cables supplied ²	DP, HDMI, USB-B	HDMI	HDMI, USB-C	DP, HDMI, USB-C, USB-C to A	HDMI	DP, HDMI, USB-C	HDMI, USB-C	
Other						Hotkey Puck G2	Self-calibration sensor, hood	
Size & weight								
Dimensions (WDH) ³	613 x 260 x 371-521mm	614 x 270 x 390-555mm	619 x 225 x 444mm	808 x 275 x 482-633mm	614 x 239 x 424-534mm	614 x 257 x 495-645mm	638 x 245 x 416-671mm	
Weight with stand	8.1kg	8.3kg	4.4kg	10kg	8.4kg	10kg	9.7kg	

¹ Monitor reliability rating in reader-voted PC Pro Excellence Awards 2023 (see issue 351, p35). N/A indicates not enough feedback to give a rating. ² All monitors include power cables. DP = DisplayPort. USB-B denotes a USB-B to USB-A cable. ³ Includes stand at its lowest height for monitors with height adjustment. ⁴ Also supports Thunderbolt 4.

							
LABS WINNER		RECOMMENDED	RECOMMENDED				
Eizo FlexScan EV3240X	Iiyama ProLite XUB2763HSU-B1	Iiyama ProLite XUB3293UHSN-B5	NEC MultiSync E274FL	Philips 34B1U5600CH	Samsung ViewFinity S9 (S27C90)	ViewSonic VG2756V-2K	ViewSonic VG3456C
★★★★★	★★★★☆	★★★★★	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆
£1,206 (£1,448 inc VAT)	£120 (£144 inc VAT)	£358 (£429 inc VAT)	£191 (£229 inc VAT)	£458 (£550 inc VAT)	£833 (£999 inc VAT)	£333 (£399 inc VAT)	£427 (£512 inc VAT)
photospecialist.co.uk	scan.co.uk	currys.co.uk	senetic.co.uk	amazon.co.uk	samsung.com/uk	uk.insight.com	uk.insight.com
EV3240X-BK	XUB2763HSU-B1	XUB3293UHSN-B5	E274FL-BK	34B1U5600CH/00	LS27C902PAUXXU	VG2756V-2K	VG3456C
5yr on-site swapout	3yr on-site swapout	3yr on-site swapout	3yr C&R	3yr RTB	2yr C&R	3yr C&R	3yr C&R
N/A	95%	95%	N/A	94%	89%	92%	92%
N/A	94%	94%	N/A	93%	87%	90%	90%
Gold	Silver	✖	✖	Silver	✖	Silver	Silver
31.5in	27in	31.5in	27in	34in	27in	27in	34.1in
3,840 x 2,160	1,920 x 1,080	3,840 x 2,160	1,920 x 1,080	3,440 x 1,440	5,120 x 2,880	2,560 x 1,440	3,440 x 1,440
16:9	16:9	16:9	16:9	21:9 (approx)	16:9	16:9	21:9 (approx)
140ppi	81ppi	140ppi	81ppi	110ppi	218ppi	109ppi	109ppi
IPS	IPS	IPS	VA	VA	IPS	IPS	VA
✖	✖	✖	✖	1500R	✖	✖	1500R
W-LED	W-LED	W-LED	W-LED	W-LED	W-LED	W-LED	W-LED
350cd/m²	250cd/m²	350cd/m²	250cd/m²	350cd/m²	600cd/m²	350cd/m²	400cd/m²
2,000:1	1,300:1	1,000:1	1,000:1	3,000:1	1,000:1	1,000:1	3,000:1
16.8 million	16.8 million	1.07 billion	16.8 million	16.8 million	1.07 billion	16.8 million	16.8 million
8-bit	8-bit	8-bit + FRC	6-bit + FRC	8-bit	8-bit + FRC	8-bit	6-bit + FRC
✖	✖	✖	✖	✖	✓	✖	✖
60Hz	100Hz	60Hz	60Hz	120Hz	60Hz	60Hz	100Hz
14ms	3ms	4ms	6ms	4ms	5ms	5ms	5ms
✖	AMD FreeSync	✖	✖	✖	✖	✖	✖
1 (1.2)	1 (1.2)	1 (1.2)	1 (1.2)	1 (1.4)	✖	1 (1.2)	1 (1.2)
2 (2.0)	1 (2.0)	1 (2.0)	1 (1.4)	1 (2.0)	✖	1 (1.4)	1 (2.0)
1 (94W)	✖	1 (65W)	1 (60W)	1 (100W)	1* (90W)	1 (90W)	1 (98W)
✖	✖	✖	✖	✖	miniDisplayPort	✖	✖
✓	✖	✓	✓	✓	✖	✓	✓
1 (15W)	✖	✖	✖	2 (1 x data only, 1 x 15W)	3 (4.5W)	✖	✖
✓	✓	✓	✓	✖	✖	✓	✓
3 x USB-A 3.2 Gen 1 (5Gbits/sec)	2 x USB-A 3.2 Gen 1 (5Gbits/sec)	2 x USB-A 3.2 Gen 1 (5Gbits/sec)	2 x USB-A 3.2 Gen 1 (5Gbits/sec)	4 x USB-A 3.2 (1 x Gen 2, 10Gbits/sec; 3 x Gen 1, 5Gbits/sec)	✖	2 x USB-A 3.2 Gen 1 (5Gbits/sec)	4 x USB-A 3.2 Gen 1 (5Gbits/sec)
✓ (2)	✓	✓	✓	✓ (combo)	✖	✓	✓
✖	✖	✖	✖	✖	✖	✖	✖
195mm	150mm	150mm	120mm	180mm	120mm	110mm	110mm
✓	✓	✖	✓	✖	✓	✓	✖
5°/35°	5°/23°	3°/22°	5°/25°	5°/25°	2°/15°	-5°/40°	-5°/40°
45°/45°	45°/45°	45°/45°	170°/170°	180°/180°	✖	60°/60°	60°/60°
✖	✖	✖	✖	Full HD	4K	Full HD	✖
✓	✓	✓	✖	✓	✖	✖	✖
✓	✓	✓	✓	✓	✓	✓	✓
✓	✓	✓	✓	✓	✖	✓	✓
2 x 2W	2 x 2W	2 x 3W	2 x 1W	2 x 5W	2 x 5W	2 x 5W	2 x 5W
DP, USB-C	HDMI, USB-B	DP, HDMI, USB-C	DP, USB-C	DP, HDMI, USB-C (to C/A)	Thunderbolt 4	DP, USB-C, USB-B	HDMI, USB-C, USB-B
✖	✖	✖	✖	✖	Bluetooth 4.2, DeX, remote control, Tizen OS, Wi-Fi 5, Smart Things Hub	✖	✖
712 x 242 x 427-622mm	612 x 210 x 388-538mm	714 x 240 x 452-602mm	610 x 233 x 377-497mm	807 x 250 x 421-601mm	611 x 135 x 410-530mm	613 x 217 x 423-533mm	807 x 217 x 423-533mm
9.4kg	5.8kg	10kg	8.2kg	11.7kg	10.7kg	8.4kg	9.1kg

What to look for when buying a monitor

Before you jump into individual reviews, it's worth considering the bigger picture when selecting which display is right for you

■ Colour giveaways

The days when a bog-standard monitor produced terrible colours are long gone: even entry-level displays will cover a solid range of colours with respectable accuracy. But that doesn't mean you need to settle for mediocrity. If you want a display with colours that punch you between the eyes, or you prize accuracy over wide gamuts, there are clues.

The first clue comes in the type of panel (see IPS vs VA, below). This rule of thumb still holds: IPS produces the whitest whites, OLED the most vivid colours and richest blacks, and VA sits somewhere in the middle.

But if you're willing to dig into the specs you'll find more hints. As we discuss in "The magic of FRC" opposite, a 10-bit panel will produce more colours than an 8-bit panel and an 8-bit panel more than a 6-bit panel – until FRC gets involved. And it can be surprisingly effective.

Reputable manufacturers also put their monitors through their own tests to produce colour coverage claims. You might see NTSC, sRGB and DCI-P3 coverage quoted, for instance. Around 75% coverage of NTSC is good, and roughly equivalent to 100% of sRGB and 80% of DCI-P3. But for films and photos to look their best, you want close to 100% for all three spaces.

Contrast ratio shouldn't be used as a proxy for quality, but it will tell you how impactful blacks will look. Nor is



ABOVE Even budget displays cover a wide range of colours with respectable accuracy

average Delta E (a measure of colour accuracy) the indicator it used to be. Almost all the monitors on test achieve an average Delta E of less than one, which used to be quite an achievement as it indicates near-perfection so far as the human eye is concerned.

There's only one way to truly see how good a panel is, and that's to read independent tests such as *PC Pro*'s.

IPS produces the whitest whites, OLED the most vivid colours and richest blacks, and VA sits somewhere in the middle

■ Gaming choice

This group test doesn't include gaming monitors as they are a niche to

themselves. However, if you're looking for a general-purpose display that also makes games look good there are three things to look for.

The first is refresh rates. Most monitors stick at 60Hz, which is fine for day-to-day use, but once you go above 100Hz you'll find that fast-paced in-game action looks smoother, and gives you a competitive advantage too. Ideally you want adaptive sync support as well, as this synchronises the refresh rate of the monitor to the output of the graphics card. AMD FreeSync is bog standard. If you're serious about gaming, you want one of Nvidia's G-Sync processors inside (see tinyurl.com/357gsync). Finally, look for low response times. For most, 4ms grey-to-grey is fine, but gaming monitors will go far lower.

■ Curved vs straight

Some people swear by curved monitors, especially gamers as it helps them feel more immersed in the action. Even more so if you opt for a setup with two, or even three, curved monitors. You'll see that all three of our curved monitors this month have a 1500R rating, which means that if they formed a circle around you the radius would be 1,500cm – so, one-and-a-half metres.

If you're using a single 32in or 34in monitor then the effect isn't so notable, but it's true that it reduces the amount of head movement required to see the corner of the screen. We don't think it's a killer reason to choose one screen or another at this size, however.

■ IPS vs VA

All the monitors here use in-plane switching (IPS) or vertical alignment (VA) panels. IPS panels tend to give cleaner whites, so are often favoured for business use, while VA panels tend to offer greater contrast and lower response times. They're also easier to use in curved monitors.

But "tend" is an important word there. For instance, the IPS panel in Eizo's ColorEdge CG2700X had a greater measured contrast ratio than one of the VA panels on test, and NEC uses VA technology in its MultiSync E274FL monitor – and that delivered fantastic whites.



ABOVE Curved monitors make games more immersive

RIGHT Some monitors, such as Samsung's ViewFinity S9, can pivot to a portrait orientation

Those rules of thumb still hold, but don't base buying decisions on them. Instead, look for independent testing.

Flexible choices

Only one monitor in this group test, the AOC 27B3CA2, doesn't include a height-adjustable stand. And we feel such a stand is now crucial so that you can put the monitor at exactly the right height (the top of the screen should be at eye level, or slightly below, so that you're always looking downwards – it's all about posture).

You'll never regret having a flexible stand, so look for the capability to pivot it through 90° and to tilt a generous amount. ViewSonic wins here, with both of its monitors providing a superb 40° backwards tilt compared to the typical 20° to 25°.

Having a VESA mount slot means that you can buy an arm or wall mount, which isn't mainstream but some people love them.

How big should you go?

There's no right answer to the size question. We set 27in as the minimum for this group test, but you may find a 24in panel makes more sense, especially if your budget only extends to 1080p screens. On a 27in screen, this gives a density of 81 pixels per inch (ppi) and that means text can look fuzzy. A 24in Full HD screen has 92ppi, so looks sharper, but now eyesight comes into the equation: if you must increase the dpi in the OS to make everything easier to read, you're losing out on resolution.

On the other hand, we review three 27in screens with a 4K resolution in this Labs, and ended up loving the sheer amount of detail on offer. Plus you don't need to move your head around to see what's going on, as you do with a 32in panel.

As we said, there's no right answer. So let's instead go for yet more rules of thumb. For most people, a pixel density of over 100ppi will look



You'll never regret having a flexible stand, so look for the capability to pivot it through 90° and to tilt a generous amount

sharp. And generally, in terms of screen size, bigger is better. We'll leave the rest of the decision to you.

Time to dock

Anyone who uses a laptop powered by USB-C should seriously consider a docking monitor. One that includes a USB-C port, that ideally features an RJ45 port for wired networking, and that includes enough ports for your peripherals. Just make sure that its USB-C port delivers enough power. In general, 60W and above is fine, but demanding laptops (especially those with discrete graphics) may want more.

Some people also like to plug multiple computers (or a console) into their monitor, in which case look for a USB-B port as you will then be able to share connected peripherals between devices.

Look at the warranty

People often skirt over the warranty when buying electronic goods, and that's fine if things don't go wrong. If something does happen, though,

you'll be extremely pleased to have paid a little more for a monitor with an on-site swapout warranty, as the company will swoop in, remove your faulty display and replace it with a working unit. With a collect-and-return warranty, they will arrange collection and attempt to repair it, usually within 14 days. And with a lowly return-to-base warranty, you're responsible for sending it back to the repair centre.

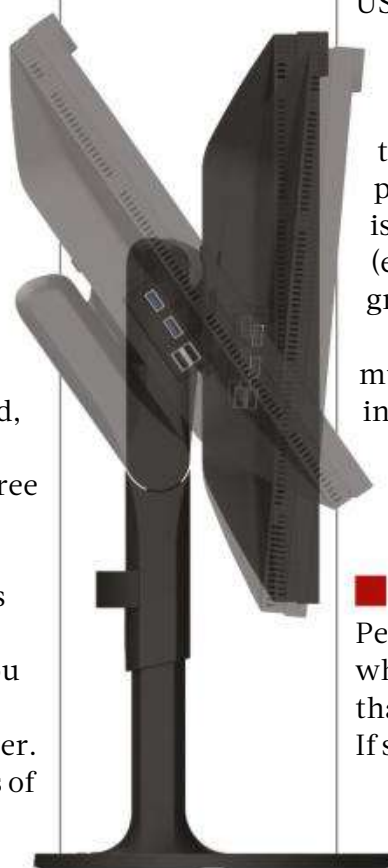
Fortunately, monitors are some of the most reliable IT kit around, which we know from our annual Excellence awards (see issue 351, p26). You can see how satisfied our readers are with each company with the scores in the feature table on p80.

Sustainability questions

Finally, we come to sustainability. Monitors are not a product that you will be able to repair yourself, so we're looking for circularity (how easy it is to reuse components at end of life), recyclability and the environmental cost of building and shipping each monitor.

Naturally, we have to rely on the companies' own environmental claims (for example, use of post-consumer recycled plastic) and third parties for this. While imperfect, EPEAT is the best proxy we've found, as it examines supply chains for the parts used in manufacturing and delivers a wider verdict on each company's actions. This is summarised in the EPEAT rating on the feature table on p80.

One final word: a product that is thrown away after three years of use is far less sustainable than one that delivers great results for ten years. This is one of the reasons why we will often recommend Eizo's monitors, for instance, despite their high initial purchase price.



LEFT A display that can be tilted will be better for your eyes and your posture

The magic of FRC

Scan the "Display colours" line in our feature table on p80 and you'll see that the screens on test range from 6-bit to 10-bit panels. As you would expect, more bits equals greater colour coverage. And a higher price.

A 6-bit panel covers 262,144 colours, but that's not nearly enough for modern tastes. That's why every 6-bit panel here has added a technology called frame rate control, or FRC. Also known as "temporal dithering", FRC

alternates between different colour shades quickly enough to simulate the desired shade.

FRC is so effective that few would be able to tell between a 6-bit + FRC panel and a true 8-bit panel, and they can both claim to cover 16.8 million colours (16,777,216, or 256^3 , to be precise).

Many manufacturers also employ FRC to boost their 8-bit panels to 1.07 billion colours ($1,024^3$). This matches the range of colours provided by 10-bit panels.



Acer Vero B277 Ebmiprzxv

Not a perfect monitor despite our five-star rating, but it's terrific value

SCORE ★★★★★

PRICE £124 (£149 inc VAT)
from currys.co.uk

We know that not everyone has hundreds of pounds to spend on a monitor, and that some people prefer to buy a pair for an extended desktop. And you'll struggle to find a better budget choice than this Full HD 27in panel.

Of course, there are drawbacks. A pixel density of 81ppi means a lack of sharpness around text edges, while you lose the sheer definition in images; if you can afford it, we'd always recommend choosing a monitor with over 100ppi. And, unlike the AOC 27B3CA2, there's no USB-C docking option here, with Acer providing a thoroughly traditional trio of video inputs instead: DisplayPort, HDMI and our old friend VGA.



You can use it as a USB hub, though, with four USB-A 3.2 Gen 1 ports (5Gbits/sec) on offer – two mounted handily on the side – if you take advantage of the upstream USB-B connection. Acer even provides the cable, along with ones for DisplayPort and HDMI.

There are a couple of surprises on the audio front, too. Not only do you get a 3.5mm jack for output, but also for input – so for connecting a 3.5mm mic. Acer even throws in a pair of surprisingly respectable speakers, which are just about good enough for listening to music, but don't turn up the volume too high. More surprising still, Acer provides

ABOVE The Vero B277 packs a few surprises for a budget display



gamer-friendly features. There's support for AMD FreeSync, to counter tearing, while a 100Hz peak refresh rate is as surprising as it is welcome.

Acer states that this monitor's brightness tops out at 250cd/m², but it reached 315cd/m² in our tests. Elsewhere its scores reflected its price, covering 92% of the sRGB gamut and 76% of DCI-P3. To our eyes, though, colours looked punchier than the similarly priced AOC 27B3CA2, especially at top brightness. Colour accuracy is okay rather than special, with an average Delta E of 1.48 but a peak of over ten. Pro designers should steer clear.

There was one final surprise: the OSD. Many budget monitors marry awkward-to-hit buttons with clunky navigation, but here Acer provides a superb joystick system coupled with activation buttons behind the display. Please, everyone else, take notice.

If you choose to buy this monitor, also take note of the exact model number. We tested the Acer Vero B277 Ebmiprzxv, and that string of letters marks it out from many other members of the B277 range; typing tinyurl.com/357acer277 into your navigation bar should take you to the relevant page on the Currys website, and we recommend you take advantage sooner rather than later.

Acer Vero CB272K bmiiprx

If you don't care about USB-C but relish 4K levels of detail, this is the monitor for you

SCORE ★★★★★

PRICE £224 (£269 inc VAT)
from currys.co.uk

You can usually be confident of aggressive pricing from Acer, and it doesn't disappoint here. The next cheapest 4K screen, BenQ's PD2706U, costs £399, while the BenQ BL2790QT costs £270 and includes a mere 1440p panel. No contest, surely?

In some ways, no. Photographers or film lovers who love detail will appreciate the level of detail on show here, and if you have good eyesight and devour spreadsheets – or tend to work with two windows side by side – the same is true for business use.

Technically, this is a superior panel too, as it's a true 8-bit display that uses FRC to increase colour coverage to 1.07 billion colours. The BenQ BL2790QT, by contrast, is a 6-bit panel with FRC



taking its colour range to 16.7 million colours. In reality, there's little between them: the Vero covers 75% of the DCI-P3 space to the 73% peak of the BenQ, and both offer similar levels of (excellent) colour accuracy.

Whites look whiter the higher you push the brightness, but this increases power consumption: at 200cd/m² the Vero wanted 20W, pushing up to 24W at full brightness of around 280cd/m², though head to the OSD and you can activate Max Brightness to take it to a searing 420cd/m². That's 70cd/m² more than Acer claims.

Switch to HDR mode and the display will boost the contrast between black and white in films and games. And

ABOVE The 4K resolution provides lots of onscreen detail



while it offers only a 60Hz refresh rate, the 4ms response time and AMD FreeSync support keeps action looking smooth. With a mediocre set of speakers inside, though, you'll want to take advantage of the 3.5mm jack sitting next to two HDMI inputs and one DisplayPort at the rear. That's your lot: there's no USB-C here, no USB hub and no RJ45 port.

The stand is nice and solid, with a huge 165mm of height adjustment and a phenomenal amount of movement: up to 35° tilt and very nearly 360° of swivel. We also like the OSD, with a trio of shortcut buttons (two of which can be reassigned) and a mini joystick for speedy control.

One final note on the Vero branding. This marks out Acer's most environmentally friendly products, and here that boils down to the use of more recycled plastic than a typical monitor. That's a worthy move, but ideally we'd be looking for an EPEAT Gold rating rather than Silver, and some design tweaks to make it easier to repair and recycle at the end of life.

But let's not be too critical. Only Eizo is truly leading the way here, and that's reflected in the price of its monitors. You may not get much in the way of frills, but a good-quality IPS panel with a 4K resolution is hard to argue with at £269.

AOC 27B3CA2

A stripped-down USB docking monitor for £150, but its sibling is a better option

SCORE 

PRICE £125 (£150 inc VAT)
from [amazon.co.uk](https://www.amazon.co.uk)

We were hoping to review the AOC 27B3CF2 in this Labs, as you can buy it for a similar price to the 27B3CA2 and they're identical but for one factor: the stand. Where the version with A2 at the end has a lightweight plastic stand that keeps the monitor at a fixed position, with the bottom roughly 110mm above your desk, the F2 offers 110mm of height adjustment.

Both monitors offer the tantalising prospect of a 27in USB-C docking monitor for around £150, and to hit that price point AOC has had to make some compromises. Let's start with the features: you only get two USB-A ports (5Gbits/sec), and nothing in the way of extras, unless you count the 3.5mm



headphone socket. Aside from this, only an HDMI port graces the rear.

Nor do you get hedonistic features such as a stand with swivelling capabilities, but as this unit weighs a mere 4.4kg it's easy to manoeuvre and to carry round an office. At least you get some tilting action, with 5° forward and 23° back.

Naturally, this is a Full HD monitor rather than 1440p. As with all its Full HD 27in rivals, you lose sharpness around text edges, and there simply isn't as much room for details, which makes it less useful for workers who like to view two documents side by side, especially if one of those

ABOVE USB docking monitors don't come much cheaper



documents is a detail-packed spreadsheet. However, whites look fine, so we were happy to use it for day-to-day tasks, and with 65W power delivery over USB-C it could be rolled out in offices where workers bring in their own laptops.

You shouldn't expect bags of colour; next to the Acer Vero B277 Ebmiprzxv, there's only one winner. It covers a reasonable 92% of the sRGB gamut, though, and an average Delta E of 1.35 suggests respectable colour accuracy. The one area of our testing where it fell down was brightness and contrast uniformity: out of 24 test areas, DisplayCal only gave one the green light.

We would love to end on a complimentary word about speaker or OSD quality, but sadly, no. In "Englishmen in New York", Sting sounds like he's singing down a phone line from the 1970s, and AOC's OSD is looking increasingly dated compared to rivals. It's okay once you get used to it, but there's an unnecessary learning curve.

All of which means that there really is only one reason to buy this screen: that you're desperate for USB-C docking and only have £150 to spend. In which case we recommend you seek out its 27B3CF2 sibling with an adjustable height stand.

BenQ BL2790QT

A unique mix of features and keen price make this Mac-friendly display a good option

SCORE 

PRICE £225 (£270 inc VAT)
from [laptopsdirect.co.uk](https://www.laptopsdirect.co.uk)

There's a lot to like about this 27in, 1440p monitor. Especially for owners of Apple laptops, as BenQ goes out of its way to colour-match its output with MacBook screens via the M-book mode. And that's just the start: the brilliant OSD, arguably the best here, makes it simple to switch profiles between Coding, Movie, Game and sepia-tinted ePaper.

Those who find their eyes are tired by the end of the day will appreciate the Care mode, which uses an ambient light sensor to keep the screen at sensible brightness and contrast levels. You can also manually adjust low blue light options, with five intensity levels to flick between, while BenQ says its Flicker-Free Technology "eliminates flickering... to reduce eye strain, fatigue and headaches". It also offers a



Colour Weakness Mode, where you can tweak the red and green filters.

A 1440p resolution is a great choice on this size of display. That works out at 109ppi, so at normal viewing distances it's sharp. Sure, you miss out on the 4K detail of the similarly priced Acer Vero CB272K, but we prefer the whites of the BenQ display.

Don't expect wide colour gamuts. Despite all those menu options, its DCI-P3 coverage stayed at around the 70% mark throughout our tests, and in reality this panel is tuned to the sRGB space: it covered 98% out of a 103%

ABOVE The 1440p resolution looks sharp on this size of display



volume in its default mode. Colour accuracy is excellent, too, with an average Delta E of 0.43. For a 6-bit panel that reaches 16.7 million colours using FRC, we were pleasantly surprised by its quality.

BenQ also packs in a pair of high-quality speakers; certainly good enough to listen to music to during a working day. There's no webcam, but oddly there is a microphone – complete with noise reduction – which may well do a better job than a standalone webcam's. Another minor surprise: this stand swivels. Its slim, square stem looks like it should stay in place, but offers 20° of movement each way. There's a decent 110mm of height adjustment, too.

Connectivity is mixed. There's no RJ45 port and no USB-B input, so the three USB-A ports (two crammed into the rear, one at the side) and data-only USB-C port can only be used if you're connecting via USB-C. Those with power-hungry laptops should note that this only delivers 65W. But, unusually, it offers a DisplayPort out for daisy-chaining a second display, and there's a 3.5mm input to go along with the normal headphone jack.

Even without these features the BenQ BL2790QT is a great-value choice, but if you'll take advantage of them then it's a no-brainer.



BenQ PD2706U

A quirky 27in 4K display with professional aspirations and a competitive price

SCORE ★★★★★

PRICE £333 (£399 inc VAT)
from scan.co.uk

If you're a graphic designer but your budget doesn't reach Eizo levels, then there are some extremely compelling reasons to choose the BenQ PD2706U. Let's start with the obvious: this is a 27in 4K screen, so that means you enjoy incredible amounts of detail.

Unlike the Eizo ColorEdge CG2700X, it uses an 8-bit panel plus FRC (see p83) to reach 1.07 billion colours, but if you're happy to stick to the sRGB, Display P3 and DCI-P3 colour spaces then it covers them all with superb accuracy. For example, switch to sRGB and it covers 98% with a 100% volume, while DCI-P3 covers 92% with no overspill. With a maximum (not average) Delta E of 1.81, you can trust what your eyes show you.



BenQ sweetens the deal thanks to a wired Hotkey Puck, which lets you easily switch between presets while a dial means you can swoosh through options. Head into the OSD and there's even a dual-screen mode, which splits the panel in two so you can work in different colour spaces side by side. This is an OSD that's well worth exploring, too, with a huge range of colour-tuning options. Buy a calibrator and you can fine-tune it to your heart's content.

It's attractively designed with slim bezels, with 150mm of height adjustment, 30° of backwards tilt but limited swivel at 20° on either side.

ABOVE This 27in 4K display has incredible amounts of detail



There's no RJ45 port and no webcam, but other than that you'll want for nothing. The DisplayPort 1.4 and HDMI 2.0 inputs are joined by a USB-C port delivering up to 90W of power, with a USB-C, USB-A and 3.5mm jack on the right-hand side. Two more USB-A ports sit at the rear alongside a USB-B connector, so you can share peripherals between computers. The speakers are just about good enough for listening to music, but you won't be blown away.

If you do buy this monitor and the brightness looks duller than you'd expect (it promises 350cd/m² and we measured a peak of 348cd/m²), head into Color | Advanced | Uniformity in the OSD and check that uniformity isn't switched on. Doing so smooths out the differences from edge to edge, but also reduces your peak brightness to around 180cd/m². We don't think it's worth the sacrifice.

The BenQ PD2706U can't hold up to all the colour options provided by the Eizo FlexScan CG2700X, which also offers a superior warranty: BenQ's PD series include three years of collect-and-return cover, so if something goes wrong you may have to wait two weeks for a replacement. Still, though, BenQ PD2706U is a compelling buy if you have £400 and will use its colour-switching skills.

Iiyama ProLite XUB2763HSU-B1

A low-energy, no-frills 27in IPS panel that delivers solid image quality

SCORE ★★★★★

PRICE £120 (£144 inc VAT) from scan.co.uk

The ProLite XUB2763HSU-B1 has one obvious rival here: the Acer Vero B277. Give or take a fiver, they cost the same, both include a 1,920 x 1,080 IPS panel and both lean heavily on their green credentials.

In the Iiyama's case, that means the plastic is 85% PCR, the packaging 100% recyclable and made from cardboard pulp, an EPEAT Silver rating and arguably most importantly an incredibly low power rating. Even at its peak 251cd/m² brightness, it drew 11W dropping to 10W at our standard test brightness of 200cd/m². That compares to the typical 16W to 18W for 27in panels in this test.

Iiyama jettisons frills such as USB-C and RJ45 connectors in its quest to hit such a low price, but let's concentrate



on what you do get. Two video inputs, one HDMI 2.0 and one DisplayPort 1.2, sit alongside a two-port USB hub. Both ports are only 5Gbits/sec, but without USB-C you're reliant on a USB-B connection back to the host PC anyway.

Both USB ports sit on the left of the screen rather than the rear, making them slightly easier to access, and the flexible, high-quality monitor stand can swivel through 45° and pivot 90°. You may also want to use the 3.5mm headphone jack at the rear after listening to the weedy speakers.

There is some entertainment potential, thanks to a 100Hz refresh

ABOVE The 8-bit panel provides good colour coverage and accuracy



rate, 3ms response times and support for AMD FreeSync to prevent tearing. We were surprised to see these features in such an affordable monitor.

More good news: this is an 8-bit panel, which always helps when it comes to colour coverage and accuracy compared to 6-bit panels that use FRC. In its default mode, the ProLite covered 94% and 72% of the sRGB and DCI-P3 gamuts respectively, with an average Delta E of 0.95. Highly respectable results.

As we'd expect from an IPS panel, whites look good, but we'll add two caveats for those who are looking for a Word or Excel partner. One is that a Full HD 27in panel has an 81ppi pixel density, so text never looks as sharp as it will on panels that go above 100ppi. The second is that the default profile's colour temperature is 6078K rather than the ideal of 6500K, so you may find it useful to play around with the colour temperature options in the easy-to-use OSD. You can also use Iiyama's i-Style presets for Scenery, Text, Cinema and Games, but don't expect to see any huge changes.

With an aggressive price, superb performance in our annual reader survey for support and reliability, plus a three-year swap-out warranty, this is a fine choice if your priorities are value and low energy consumption.

NEC MultiSync E274FL

Ideal for large rollouts, this 27in Full HD monitor packs USB-C and RJ45 connectivity

SCORE ★★★★★

PRICE **£191 (£229 inc VAT)**
from [senetic.co.uk](https://www.senetic.co.uk)

In some ways, the NEC MultiSync E274FL's natural rival in this Labs is the AOC 27B3CA2, which on the surface has one obvious advantage: price. Where the NEC costs £191 exc VAT, the AOC costs a mere £125. For the businesses that are likely to buy this monitor, however, that extra £66 should be seen as an investment.

Certainly you can expect the NEC's stand to live up to the abuse of employees, as it feels robust to the point of over-engineered. The monitor lifts smoothly through its 120mm of height adjustment, while the screen rotates easily through 170° in either direction.

Another big difference comes in the RJ45 port at the rear, which not only offers users connection to the



local network but gives admins a route to control display settings (and keep track of assets) via Sharp/NEC's NaViSet Administrator 2 software.

The rear also houses the crucial USB-C connector, even if we would prefer more power than 65W, plus DisplayPort and HDMI inputs. There's no USB-B input, so forget sharing keyboards and mice between two computers, and it would have been nice to see more than two USB-A connectors as well. These are tucked away at the rear, which would be annoying except that the screen smoothly pivots (in either direction), and that flexible stand makes it easy to access all the ports.

ABOVE The E274FL has lots of office-friendly features



Unusually, NEC has opted for a VA panel rather than IPS. That can sometimes lead to imperfect whites, but once we switched to the sRGB colour preset we had no complaints. Colour coverage is par for the course, peaking at 94% of the sRGB space and 75% of the DCI-P3 gamut, but we were pleased to see a peak brightness of nearly 300cd/m² compared to the claimed 250cd/m².

It's also easy to adjust settings thanks to NEC's best-in-class OSD. Controlled entirely by a joystick, and backed by snappy performance, you can flick between colour temperature presets, tune it yourself and explore the admittedly limited options. Think Eco mode, DV mode and increasing response times – but this is not a gaming monitor, with a 60Hz refresh rate and 6ms grey-to-grey response time at best. As for the pair of 1W speakers... well, music is bearable, but think video calls rather than after-hours entertainment.

With a three-year warranty and so many office-friendly features, the MultiSync E274FL earns its Recommended award for business rollouts rather than outright quality. But if that's what you need it for, this monitor is a terrific choice.

ViewSonic VG2756V-2K

A high-quality 1440p display, but wait for the VG2757V-2K if you want a webcam

SCORE ★★★★★

PRICE **£333 (£399 inc VAT)**
from [uk.insight.com](https://www.uk.insight.com)

As a rule, we're fans of 1440p 27in screens. They feel more spacious than 1080p rivals, making it a pleasure to work on two windows side by side, and text looks sharp. This is one reason the £270 BenQ BL2790QT wins a Recommended award. The ViewSonic VG2756V-2K offers similarly high image quality, plus a bunch of extra features to justify its significantly higher price.

Chief among these is its USB-C connection. This makes the monitor both more suited to office rollouts and more appealing to laptop users, with up to 90W of power delivery. ViewSonic even sweetens the deal by embedding a pop-up 1080p webcam into the top of the display, complete with LED lights, but those hoping to launch a streaming career will be



disappointed: the results are so grainy we would only use it in an emergency.

You can also use the webcam if you connect over HDMI (not DisplayPort), thanks to a USB-B connector. This gives access to the two USB-A ports, with one sitting handily on the side, and also means you can connect two computers and jump between them with the same keyboard and mouse. The final port of note is a handy RJ45 connector, adding yet further to this monitor's docking credentials.

Don't expect pristine sound from the pair of 5W speakers, but they go loud, include more bass than most rivals, and vocals and instruments

ABOVE This well-built monitor offers quality and lots of features



come out clearly. There's also a solid microphone, so long as you ignore its noise-reduction features, but ViewSonic's decision to label the OSD navigation keys with volume and mic controls rather than oversells this display's videoconferencing abilities. And those labels, which overlay the buttons, only add to the confusion once you're in the OSD. We've used far worse OSDs, and at least the menu responds quickly to presses, but it's not going to win any user experience awards.

Not that there's a huge amount of colour control here anyway. The 8-bit panel has a wider gamut than rivals based on 6-bit and FRC (see p83), covering 100% of the sRGB space and 81% of DCI-P3, but switching colour profiles makes little difference to the panel's properties. Windows users should stick to the default colour profile, Mac users the ready-made preset to match MacBooks, and everyone should be happy with the whites and colour accuracy – the average Delta E is a terrific 0.32.

As ever with ViewSonic, build quality is excellent, with the stand offering plenty of movement – including 110mm of height adjustment and an exceptional 40° of backwards tilt. We look forward to reviewing its successor, the VG2757V-2K, which has an upgraded camera.



AOC CU34P3CV

We're dumbstruck by the amount of quality and features you get for the price

SCORE ★★★★★

PRICE £317 (£380 inc VAT)
from amazon.co.uk

If we purely decided star ratings based on value for money, then this curved 34in monitor would be walking away with ten. It's almost unbelievable that you're buying this much quality for less than £400 inc VAT: in terms of whites, colour coverage and colour accuracy it was consistently in the top five of a competitive field. It even topped the table for brightness variation, and while its peak of 355cd/m² can't match the very best screens, that's still more than enough to be viewable in bright environments.

Nor does the CU34P3CV sacrifice any vital features to hit a price. It ticks all the key points for a USB-C docking monitor, with 65W power delivery plenty for most laptops, an RJ45 port, four USB-A ports (two at the rear, two



on the left) and a USB-B port to share peripherals between computers. HDMI 2.0 and DisplayPort 1.4 inputs round out the connectors.

There's even some gaming ability. AOC generously pumps up the refresh rate to 100Hz, while the VA panel offers a respectable 4ms response time (grey-to-grey) with a measured contrast ratio of 3,370:1 to help see the action in darkened corners. The less time we spend talking about the speakers the better, however, as they're arguably the worst here; Sting was less "Englishman in New York" and more "Englishman in a Wheelie Bin", such was the echo.

ABOVE The AOC CU34P3CV offers incredible value



As with the AOC 27B3CA2, we frequently cursed the OSD. Navigation is made all the more difficult by AOC's decision to mark the key functions with the faintest of icons on the black bezel. Perhaps it's fortunate that the OSD offers little in the way of options; aside from the default colour profile, your only notable choice is an

sRGB mode. But we don't recommend you use this, as it reduces sRGB coverage to 88% and DCI-P3 to 68%.

Other drawbacks? While AOC provides a good three-year warranty, it's return-to-base so you'll pick up the courier costs. And despite the promotional material boasting of a "three-sided ultrathin bezel design", your jaw won't drop in wonder at its beauty. That's in part due to a basic plastic finish, which stretches to the chunky base of the stand – despite the attempt to add a brushed metal effect.

The stand again puts function over aesthetics, but we're not going to argue with 150mm of height adjustment. In truth, no-one should buy this monitor for its beauty. Instead, buy it for the superb screen quality, the phalanx of features and the astounding price.

Iiyama ProLite XUB3293UHSN-B5

Stripped back in places, but this 32in 4K panel offers good image quality and great value

SCORE ★★★★★

PRICE £358 (£429 inc VAT)
from currys.co.uk

Why pay over a grand for a 31.5in 4K monitor – namely the Eizo FlexScan EV3240X (see p91) – when Iiyama is selling this ProLite for a third of the price? There are reasons, particularly in terms of visual impact, but in truth you aren't making many sacrifices.

Let's start with image quality. In our technical tests, there was little to separate the two: they both cover 100% of the sRGB gamut, and the ProLite even has the edge for DCI-P3 coverage at 95% compared to 87%. Nor are we going to complain about an average Delta E of 0.81, which reflects the panel's strong colour accuracy. In fact, it's only side by side that you notice the extra punch provided by



the Eizo's 2,318:1 contrast compared to 1,092:1 for the Iiyama. Whites are crisper, too, but in isolation we don't think people will be disappointed.

Iiyama provides all the inputs we look for. You can connect via DisplayPort, HDMI or USB-C, with the latter offering a modest but still reasonable 65W of power delivery. There's an ever-useful RJ45 connector, while the USB-B port means you can share a keyboard and mouse between two connected computers. You only get two USB-A ports, but they're easy to access on the side and, while this screen doesn't officially support pivot mode,

ABOVE Image quality and a wealth of inputs make this a good choice



the fact that it rotates makes it simpler to plug in connectors. The stand is plain Jane plastic in appearance, but it offers plenty of movement – including 150mm of height adjustment – and feels solid.

The OSD echoes this back-to-basics ethos, with the fiddly controls providing access to few functions. Colour options are limited to three colour temperatures (warm, normal, cool) plus one user-adjustable option, and a handful of Iiyama's i-Style presets – Game, Cinema, Scenery, Text and Standard. Still, that's plenty for most users.

Audio comes courtesy of two 3W speakers, which pack volume and can cope with music at a push, but the balance veers far more towards treble than it does bass. You won't enjoy finely detailed classical music here, but we've heard far worse in this Labs. At this price, we're also happy with a three-year swapout warranty, and note that Iiyama won our most recent Excellence awards thanks in part to its reliability figures.

The biggest compliment we can pay the ProLite XUB3293UHSN-B5 is that it holds up well in comparison to the exceptional Eizo FlexScan EV3240X. It's far more basic than its luxurious rival, but offers solid image quality and simply stunning value for money.

Philips 34B1U5600CH

Another solid 34in curved widescreen, but it's made to look expensive by the AOC

SCORE ★★★★★

PRICE £458 (£550 inc VAT)
from [amazon.co.uk](https://www.amazon.co.uk)

You can almost consider the Philips 34B1U5600CH as the spoilt older brother to the AOC CU34P3CV. They appear to share similar genes: both are 34in curved VA panels boasting a 3,440 x 1,440 resolution, and they gave near-identical (and strong) performances in our technical tests. Whites look good, DCI-P3 colour coverage is strong at 85%, and an average Delta E of 0.58 means you can trust that colours are accurate.

The reason it's spoilt is that this monitor gets many of the features that are missing on its AOC rival. There's a respectable, albeit grainy, 1080p webcam that supports Windows Hello, a power sensor that switches the screen off if it detects no-one is there, plus an



ambient light sensor. The speakers are also better; hardly hi-fi quality, but you can actually listen to music on the Philips 34B1U5600CH.

It wins the numbers game, too. Its refresh rate is better, at 120Hz to 100Hz. Philips also quotes a higher peak brightness, of 350cd/m² to 300cd/m², although in our tests the gap narrowed with 368cd/m² versus 355cd/m². And the one-upmanship stretches to the ports, with its main USB-C connector delivering 100W of power to the AOC's 65W. It also adds two USB-C ports to the four USB-A ports found on the hub, with half on the left-hand side of the display and half at the rear.

ABOVE The Philips display is a good, if expensive, option



The Philips also has a superior stand. That's true for the numbers – note its excellent 180mm of height adjustment – but also for fit and finish, with its swivel option being far smoother. Philips' OSD is also easier to navigate, but just like the AOC it's difficult to see what buttons you're pressing, and don't expect

a huge range of useful options. It's worth using the SmartImage presets, though, as it can be useful to jump to, say, Easy Read or Low Blue Mode.

But here's the challenge for Philips. At well over £500, it's a hefty chunk more expensive than the AOC – its equal for panel quality – while the also excellent-value-for-money Iiyama ProLite XUB3293UHSN-B5 sits in the middle. And the Iiyama has a better warranty than the Philips, as it offers on-site swapout rather than return to base (where you have to cover courier costs to get it repaired).

The 34B1U5600CH is a fine screen, and if you'll take advantage of its extra features then you can argue it's worth the premium over the AOC. However, it needs to drop below £500 to compete for awards against this month's ferocious competition.

ViewSonic VG3456C

Not the punchiest of panels, but the VG3456C wins for style and covers most bases

SCORE ★★★★★

PRICE £427 (£512 inc VAT)
from [uk.insight.com](https://www.uk.insight.com)

A letter can make a big difference in a monitor name, and none more so than here. The ViewSonic VG3456 (see issue 326, p95) is a highly affordable flat-screen monitor that you can now purchase for around £250, while the VG3456C is curved – exactly like the AOC CU34P3CV and Philips 34B1U5600CH. They also share the same 3,440 x 1,440 resolution, giving you huge amounts of space on which to spread your windows, and VA technology.

The ViewSonic is the most stylish of the three, with slim bezels and a fuzzy speaker-like finish to the bottom edge of the monitor. We only wish the pair of 5W speakers could live up to the billing, but like so many others here they're better suited to



speech radio and web calls than listening to music or enjoying films.

We were also struck by this monitor's tilting skills: you can push it backwards by 40°, which may well be the killer feature for some situations. While its height adjustment is limited to 110mm, that should be enough for most setups, and we'd give it a firm tick for stand quality overall: you feel like you're buying a high-quality piece of kit.

The panel is much more average. Rather than true 8-bit colour, this is a 6-bit + FRC affair, and this is one reason why its gamut is more limited than its curved 34in rivals. In native mode, it covers 74% of the DCI-P3 gamut compared to 88% and 85% for

ABOVE The curved 34in screen gives you huge amounts of space



the AOC and Philips. But if you're happy with the sRGB gamut then it's fine, covering 97% out of a 104% volume. Accuracy is strong, too, with an average Delta E of 0.69.

With a stated peak brightness of 400cd/m², we were surprised to find the monitor maxed out at 280cd/m² in our initial tests. But then we went into the (excellent) OSD and discovered that ViewSonic ships it with the Energy Saving mode switched on; deactivating this pushed the panel up to 435cd/m². This also boosts the whiteness of the whites, but the penalty comes in power consumption: 48W compared to 31W at 200cd/m².

ViewSonic doesn't load this monitor with extras, so if you're hoping for a webcam or KVM switch then you'll be disappointed (there's no USB-B input, either). But it does cover the docking station basics, with an Ethernet port and a USB-C video input that can deliver 98W of power. All four USB-A ports are 3.2 Gen 1, so 5Gbits/sec, with two sensibly positioned on the left-hand side.

It adds up to a solid curved 34in monitor, even if we prefer the punchier colours from the AOC and Philips. If the price drops closer to £400, it will become a strong choice.



Eizo ColorEdge CG2700X

A fantastic investment for creative studios thanks to the trust you can have in its long-term colour accuracy

SCORE ★★★★★

PRICE £2,149 (£2,579 inc VAT)
from wexphotovideo.com

The ColorEdge CG2700X stands out from other monitors in this group test for many reasons. First, this is a monitor absolutely and unapologetically designed for creative professionals. Second, and tied to that, its huge top bezel contains a built-in calibrator (more on that in a moment). Third, its price, which is six times that of the BenQ PD2706U – which is also a 4K 27in monitor with its eye on the creative market.

A 10-bit panel sits at this monitor's foundation. As we mentioned in the buyer's guide on p82, this means it can cover 1.07 billion colours without the use of FRC, and it's one of the indicators of professional-level quality here. Years ago, you would have needed a pro-quality graphics card to supply a 10-bit signal, but the rising quality of consumer graphics cards (and Nvidia's Studio driver) means this is no longer the case.

However, the ColorEdge still needs to be part of a colour-managed system if you want to maximise your investment. Eizo's ColorNavigator 7 software is here to help, as it not only helps end users set up an individual monitor but also means a company can ensure all the ColorEdge monitors, in all their offices, will display the same colours.

It enables them to control the brightness, too, and Eizo is keen to promote the sustainability of its ranges. A big part of that is power consumption, and while this monitor can push all the way up to 545cd/m² it still looks great at 200cd/m² (and, unusually, you can push it right down to 40cd/m², while the OSD even tells you how bright it is). Using the supplied monitor hood helps to control the appearance of colours.

Eizo promises that this monitor will be up and running, producing



accurate colours, after three minutes rather than the 30 minutes creatives are used to waiting, which will help if you need to set it up on shoots.

Then there's its most unique feature: the built-in calibration tool.

You can set this to swing down automatically after a set number of hours (50 to 500) or at regular times – this could be daily, weekly, monthly or even annually. You can even keep working as it performs the calibration.

The other brilliant feature for designers is that you can so easily

jump between pre-calibrated colour spaces. These include the expected sRGB, Adobe RGB and DCI-P3 gamuts to those favoured by video editors: BT.2020 and BT.709. If you're using a BT.2020 clip, it can even warn you that it can't be reproduced in BT.709 and can show you how it will look to audiences who have more standard TVs.

Anyone who needs to edit HDR footage will also appreciate its support for hybrid log-gamma (HLG) and the perceptual quantization (PQ) curve, and you'll even see a warning if areas of an image – think extreme whites – can't be accurately displayed as they go beyond the peak brightness of the monitor itself.

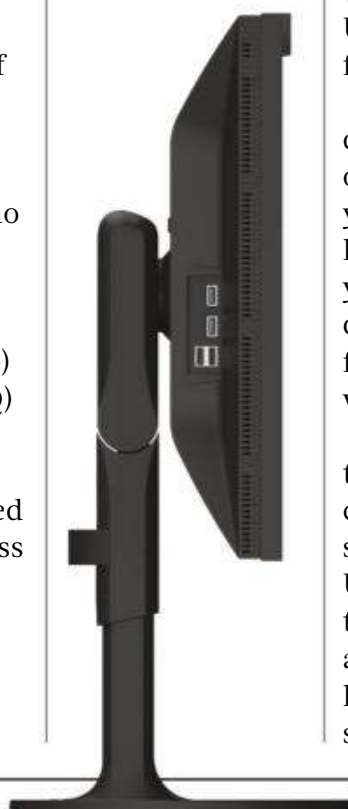
Eizo is also notorious for its attention to detail, and that extends to its support for 100W when powering devices over the USB-C

ABOVE The ColorEdge CG2700X is as colour-accurate as you'd expect for the price



LEFT Eizo's monitor is the pinnacle of quality

BELOW Two of the four USB-A ports support USB 3.2 Gen 1



connection. Power equals heat, and that affects colours unless you dissipate it fast. And that's why there are two metal grilles at the rear of the monitor: not merely to look good, but to allow any excess heat to be removed without recourse to noisy fans.

We also love the OSD. It's by far the most informative on test, and it's packed with options that allow you to switch to different gamuts, gamma settings, ICC profiles and colour temperatures within seconds. You can also prioritise contrast deviation.

Alternatively, so long as you have a USB connection, you can use ColorNavigator 7. The rear offers a USB-B port next to the RJ45 connector (vital if you want to manage this monitor across a network), plus DisplayPort 1.2 and HDMI 2.0 inputs. Over on the left-hand side you'll find four USB-A ports, with two in blue supporting the faster USB 3.2 Gen 1 standard, but note the lack of a second USB-C port. The only other missing feature is a pair of speakers.

We've covered a lot of technical detail, but ultimately what Eizo is offering is trust. Trust in the colours you see, but also that this monitor will keep on delivering the goods for years. That's reflected in the build quality of the monitor and in the five-year on-site warranty, where Eizo will come and replace the faulty unit.

Clearly, you're paying for this in the up-front price, and many creative companies will get more value out of six BenQ PD2706U screens instead. Ultimately, though, the CG2700X is the pinnacle of quality and, so long as you support it with the right hardware and colour management system, it's worth the investment.

Eizo FlexScan EV3240X

Quality never comes cheap, and that's emphasised here – but if you can find the money, it's a terrific monitor

SCORE ★★★★★

PRICE **£1,206 (£1,448 inc VAT)**
from photospecialist.co.uk

Sometimes, numbers can't do justice to products. In fact, if you judged this monitor by numbers alone then it wouldn't even win an award, let alone the Labs Winner gong. No matter how well it might perform in technical tests, there was one number that would always rule them all: the price. It's more than three times as expensive as the award-winning Iiyama ProLite XUB3293UHSN-B5, despite them sharing the same 4K resolution and 31.5in screen diagonal, and scoring similarly in our tests.

We think the Iiyama is great – and stupendous value – but the Eizo will make you go “wow” in a way that no other monitor on test here can. Much of the credit for this must go to the combination of a 2,000:1 contrast ratio and the colour characteristics of an IPS panel. Aside from mini-LED panels, we've never been hit so forcefully between the eyes when looking at photos or films. Couple that with gorgeous whites and it's the best all-round image quality we've seen in a monitor this size.

Naturally, you also benefit from the extras offered by Eizo monitors. Let's start with the OSD, as this is not only incredibly intuitive and speedy – Eizo provides the best OSDs here by some margin – but also offers the ability to tweak colours to fine margins. Head into the Advanced Settings, for instance, and you can control hue, saturation and gain.

However, you'll probably find it easier to switch between the presets. Those are sRGB, Paper, Movie and DICOM (for medical environments), plus two user-defined slots. The sRGB preset is particularly impressive, locking the panel down to exactly 94% of the gamut, without any spillover, and with an excellent – albeit not exceptional in this month's company



– average Delta E of 0.61. Switch to Movie and it leaps from 66% coverage of the DCI-P3 gamut to 87% – again, with no leakage and strong accuracy.

While you don't get the high-end colour control provided by Eizo's ColorEdge monitors, nor its ColorNavigator software, Eizo's InStyle software is worth the 6.6MB download. Connect over USB-C or USB-B and you can save your colour preferences (useful if you connect to different Eizo screens in a hotdesking office) and activate the circadian dimming option – this gradually shifts the colour temperature over the course of a day.

The separate InStyle server tool offers some basic management for IT teams, too, so long as the monitor is connected via the wired network port. Useful if you want to prevent users pushing up the brightness too high or control how quickly its Power Save mode kicks in.

There are plenty of ways for users to control how much energy this monitor draws, too. Activate the EcoView mode in the OSD and it will change the brightness based on the ambient light conditions, and if you want to take manual control then it goes all the way from 1cd/m² up to 400cd/m² (despite its official peak of 350cd/m²).

As with the ColorEdge, you also benefit from a generous five-year warranty with the promise of on-site swapouts if something goes wrong.

ABOVE The FlexScan EV3240X is a winner with wow factor



LEFT Eizo provides a generous number of ports, including RJ45

BELOW The solid stand offers plenty of adjustment options

We also love how easy it is to set up Eizo monitors: they come ready assembled, so it's simply a matter of lifting them into place.

Here, despite what looks like a pair of fixed feet, the stand delivers a huge amount of flexibility. You can rotate through 45° in either direction, tilt it up 35°, adjust the height by an astonishing 195mm and pivot it 90° into portrait mode (imagine having two of these monitors side by side). We love the sleek bezels, too, giving the monitor a more modern look than previous Eizo screens.

Eizo provides a generous number of ports, with a pair of HDMI inputs and a DisplayPort alongside USB-C. Two USB-A 3.2 Gen 1 ports sit at the rear, too, with one more to the side next to a USB-C downstream port for connecting peripherals. This delivers up to 15W of power while the main USB-C connector can feed up to 94W.

There are even a pair of 3.5mm jacks, one for a mic and the second for headphones. You may never need this, though, as a pair of impressive 2W speakers round off the FlexScan's features. While they don't offer the miracle of a strong bass response, they're a surprisingly good choice for listening to music. You may even decide you don't need a separate pair of speakers.

Admittedly, that £50 saving only fills a small part of the nigh-on £1,500 you'll need to pay for this monitor. Despite the many advantages offered by the FlexScan EV3240X over Iiyama's far cheaper rival, that's tough to justify. But trust us when we say that if you find the extra budget for this monitor, you'll appreciate the purchase years after the pain of paying the bill has gone.



3D monitors on the rise

While 3D TVs never quite took off, the eye-catching technology in the latest glasses-free 3D monitors make them a great choice for designers, architects and even gamers

Turn to p48 of this month's issue and you'll see our verdict on the Lenovo ThinkVision 27 3D. This is the harbinger of what we expect to be a swathe of glasses-free 3D monitors, but these aren't going to be aimed at gamers or movie fans. Instead, the target market is 3D designers, 3D modellers, schools, medical institutions and more.

Nor is Lenovo on its own. Both Acer and Sony have already released portable monitors based on the technology, and we know that Acer has its own 27in desktop display – the Acer SpatialLabs View Pro 27 – on the way.

■ Lenticular technology

The basic concept behind these panels is nothing new. In fact, the idea of sending different signals to the eyes based on the viewer's position dates back to "tabula scalata" paintings created in the 16th century, where the viewing angle of a painting (split up into strips) determined which of two images people saw. Pick up a pound coin dated 2017 or later and you'll see the "£" symbol changes to a "1" in a similar way.

Now let's jump forward to 1838. This was when British scientist and inventor Charles Wheatstone unveiled his stereoscope, which wowed audiences by showing two subtly different images to the left and right eyes. No doubt you used a stereoscope of some form as a child. Anyone who had the misfortune of watching *Jaws 3-D* in cinemas in 1983 will again be familiar with the effectiveness of sending different images to the left and right eyes.

What's clever about this new generation of stereoscopic 3D screens is that there's no need to wear special glasses or to change your viewpoint. Instead, lenticular lenses (which themselves date back a century) overlay the screen. When the 3D technology is activated, half of the available pixels are beamed to your left eye, the other half to your right eye. All the new stereoscopic 3D displays feature eye-tracking technology so that they know exactly at which angle to adjust the lens.



ABOVE 3D monitors are likely to be popular among 3D designers

Although this makes it sound simple, the reality is far more complex and relies on multiple tricks to work. For example, our brains deduce whether objects are closer by looking at relative sizes – we know that a car is smaller than a building – and this

gives us an indication of depth. Software developers (and film-makers) can also use subtle blur effects to send messages to our brains that objects are further away than those in focus.

What's clever about this new generation of stereoscopic 3D screens is that there's no need to wear special glasses

■ Soft revolution

So the hardware is here. As ever in computing, however, it's useless without the software to support it. Fortunately, 3D modelling is hardly a new concept. From architecture to car design, from biology lessons to *Avatar*, there is already both supply and demand with a rich ecosystem of products and materials.

If all you want to do is enjoy 3D viewing on these devices, then you first need to install the manufacturer's viewing software. In Lenovo's case, that means 3D Explorer. Acer provides SpatialLabs viewing software, too. These both

provide plugins for popular 3D software, so you can export models and then view them in 3D. It's a slick process that "just works".

■ Breaking out of the niche

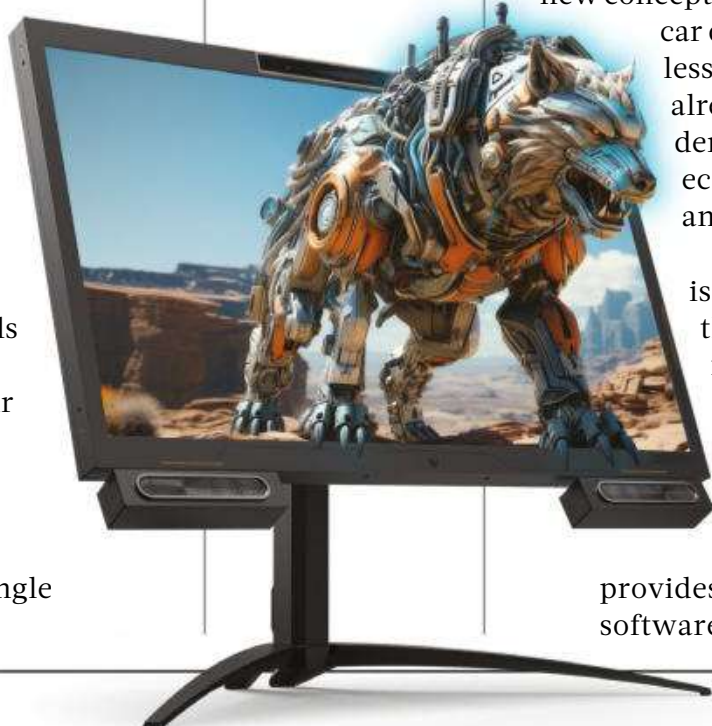
It should be obvious why those who work in 3D design and architecture would be interested in this new breed of monitors, but who else might buy one?

Certainly gamers should consider it. AR and VR headsets are helping to develop a market for 3D-enabled games, and it's relatively simple to port a 2D game to 3D as the depth information is already baked into the engine. Once you get to 27in, you're reaching the point where you can immerse yourself in the 3D world, too (the effect is less compelling on smaller screens). Acer is again in prime position here, having announced its Predator SpatialLabs View 27 at CES for \$1,999.

There are also sales environments. If you want to show a prospective car buyer exactly what an interior will look like, bringing it to life in 3D on a screen may be just be the killer weapon. Likewise kitchen planners hoping to capture that big sale.

However, as we discuss in the review of the Lenovo ThinkVision 3D, you'll need recent, powerful hardware to keep the output looking smooth. And with limited supply, we think it's likely that 3D monitors will stay in their niche for some time yet.

BELOW The Acer Predator SpatialLabs View 27 is due out this year for \$1,999



Samsung ViewFinity S9 (S27C90)

A standout monitor for its “smart” TV and gaming features, its hardware calibration and its price

SCORE ★★★★★

PRICE £833 (£999 inc VAT)
from [samsung.com/uk](https://www.samsung.com/uk)

On its website, Samsung lists this monitor as the S90PC ViewFinity 5K Smart Monitor, but it feels more like a smart TV on first “boot”. It asks to be connected to your Wi-Fi network, and once you’ve jumped through various hoops you’ll find yourself in Samsung’s TV Plus section with a huge selection of live channels. Just to hammer home the point, your first interactions are via a remote control rather than an OSD.

The remote offers dedicated buttons for Disney Plus, Netflix and Prime Video. We watched the first few minutes of *Top Gun: Maverick* and the detail was so rich on the 5K panel that we picked up several details we didn’t spot in the cinema. Samsung backs up the visuals with the best speakers here by some distance. Whisper it, but there’s even bass on show.

You can also play games via Samsung’s Gaming Hub, with an option to sync your Amazon account via Luna. It supports Xbox Game Pass and Nvidia’s GeForce Now services, too. Games look great, despite the S9’s modest 60Hz refresh rate.

But we’re getting this the wrong way round, for Samsung is promoting the ViewFinity S9 as a work first, play later monitor, so let’s head to the Workplace area of its Tizen OS interface. Here, you can wirelessly connect to a PC, a Samsung phone (using DeX) and even log in to your Microsoft 365 workspace.

The latter is aggravatingly slow, though, and there’s also annoying lag on the wireless connections to your PC and phone, so you’ll reach for the Thunderbolt cable where possible. And at this point, finally, it becomes a normal monitor. Albeit one with a 5K (5,120 x 2,880) resolution, which



gives a quite stunning 218ppi density. Overkill, but photographers will love the detail, and it makes the 109ppi of a 1440p 27in screen feel distinctly average.

At this price we expected mini-LED technology, but IPS is in place as usual. It’s an 8-bit panel with FRC, giving 1.07 billion colours, but what will matter for professional users is that it comes pre-calibrated for sRGB and DCI-P3. Not Adobe RGB, though, which is a surprise as

the ViewFinity S9 lists Pantone validation among its many features.

There are also two slots available in the OSD for hardware calibration via recent Samsung phones. Using the Smart Things app, you can opt for a simple 30-second calibration for basic colours and brightness, or complete a ten-minute “professional” calibration to either the sRGB or DCI-P3 colour spaces. The result was little better than the pre-calibrated versions, but could be useful if the colours drift over the years.

Most of the time, though, you’ll find the default “Eco” mode does the job, which uses the panel’s native colour profile and covers 99% of the DCI-P3 space. We’re not sure “Eco” is the correct term, however, as this is the most power-intensive 27in display here, consuming 42W at 200cd/m²

ABOVE A detachable 4K webcam can be attached to the top of the stylish S9

LEFT A 5K resolution makes everything look incredibly detailed

BELOW The stand offers a limited amount of tilt

and 61W at its peak 629cd/m². Films benefit from even higher peaks thanks to support for HDR.

The monitor itself looks stunning. Its thin bezels and stylish finish remind us of Apple’s Studio Display, and while we would have liked more tilt than 15° back and 2° forward, at least it includes 120mm of height adjustment. Only an ambient light sensor interrupts the clean lines of the front display, with the traditional OSD controls tucked next to a sprinkling of connectors at the rear: a miniDisplayPort, one USB-C input (complete with Thunderbolt 4 support), and three USB-C connectors for peripherals. The main USB-C port delivers 98W of power but the others a miserly 4.5W, which is surprising when you consider the gigantic power brick – think cigar case – that you’ll want to hide under your desk.

There’s one final bonus here: a 4K webcam. It comes with a privacy cover, albeit one that’s easy to lose, but for ultimate privacy simply disconnect it. The slimline unit attaches magnetically to the rear of the panel via pogo pins, so you can chuck it in a drawer when not in use. When it’s time for calls, its superb detail capture will surely impress.

Whether it’s great enough to justify the price is a different matter. If it included mini-LED technology we could understand the £999 tag, but the S9 – while a lovely monitor – only makes sense for those with money to spare and the need for a 5K work screen during the day and an entertainment centre at night.





How we test

Details of the exhaustive procedures through which we put each screen

As with all our testing, where possible we use a mix of real-world and technical tests to determine the quality of our products. Here, that means using each monitor as our daily work screen to see not just how enjoyable it is to look at but its usability: how intuitive is the on-screen display, how well engineered is the stand, how convenient are the ports?

We also explore the OSD in depth to see what options it provides users. In particular, we will praise screens that allow people to switch between colour profiles – say from sRGB to DCI-P3. But only if that switch is effective, which is where our technical tests come in.

These use an X-Rite i1 Display Pro colorimeter in tandem with the display calibration and profiling software, DisplayCal. We measure each display's maximum brightness in cd/m², its contrast ratio and colour temperature, and each panel's colour gamut as a percentage of the sRGB, DCI-P3 and Adobe RGB gamuts. We take these measurements in the default setting (as supplied), and in those colour profiles if available.

We also test the evenness of the LED backlights by measuring brightness and contrast across 25 points on the screen. In addition, we test each monitor's colour accuracy (using the sRGB profile if available) from a central point on the screen. This process measures how close the display colours are to their intended shade. The difference is measured in the unit of colour difference, Delta E: the higher the figure, the poorer the match.

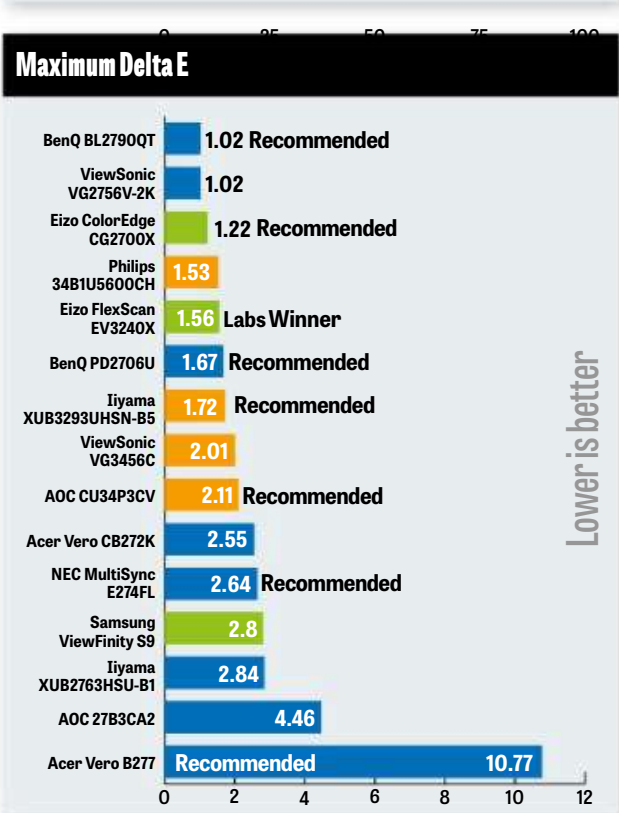
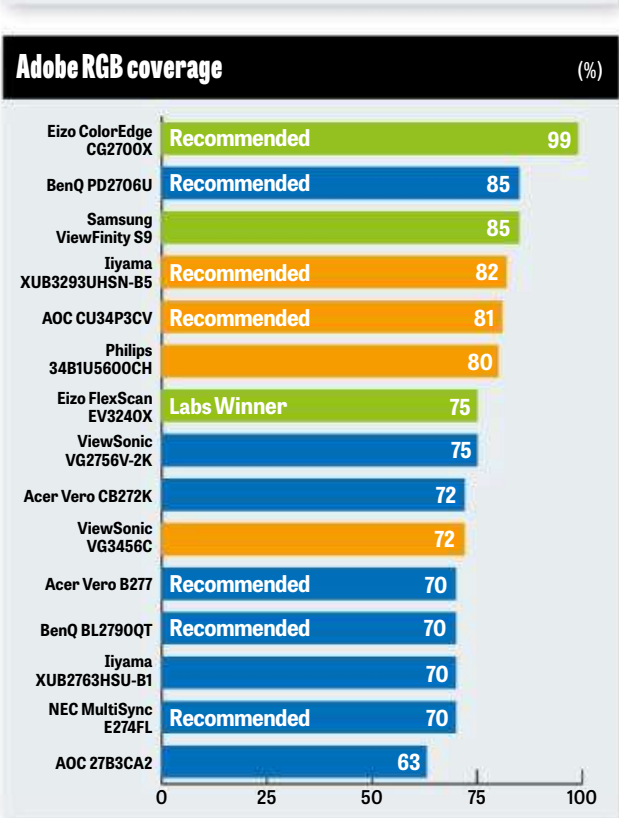
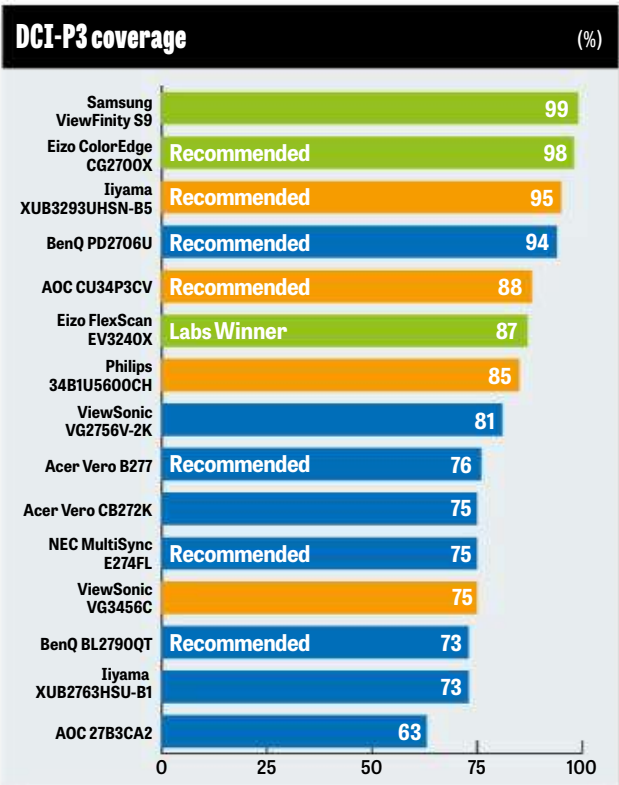
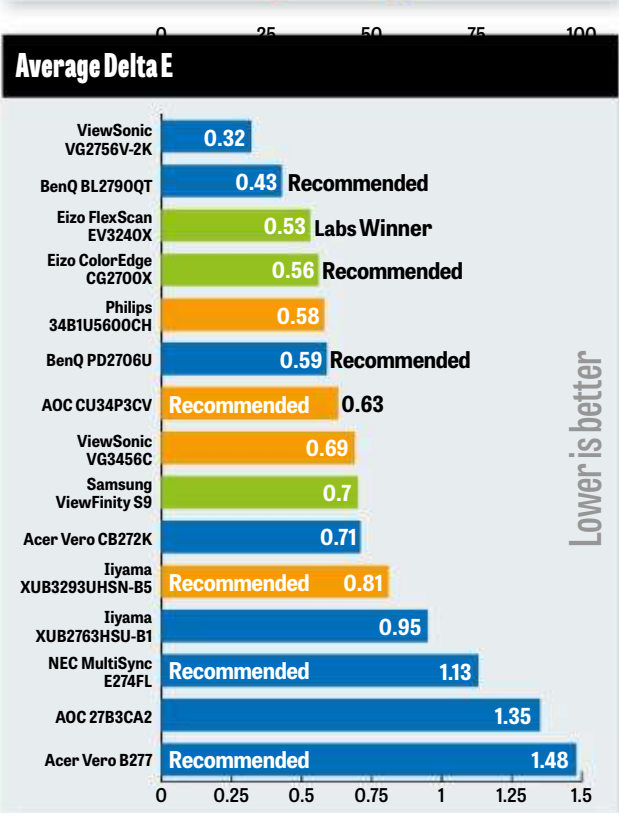
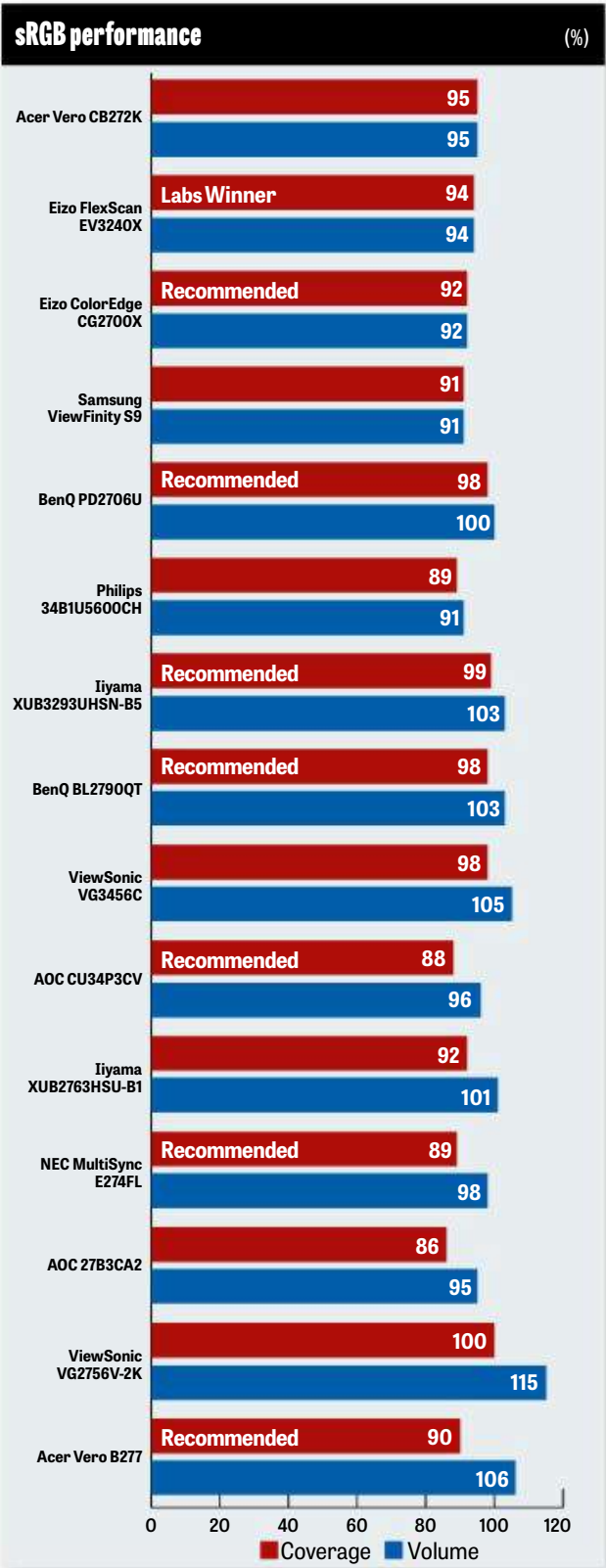
Finally, we check the power consumption of each monitor at 200cd/m² and at its peak brightness.



ABOVE A X-Rite i1 Display Pro colorimeter helps us determine a display's image quality

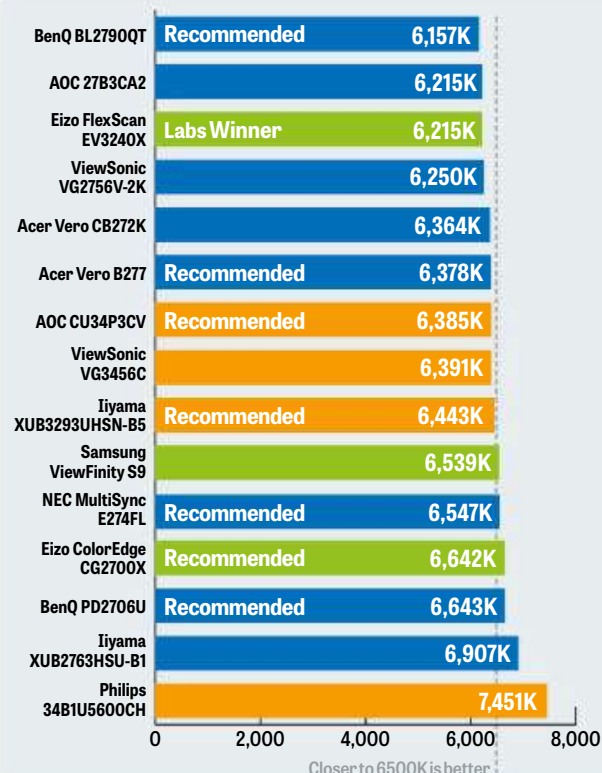
Quality test results

COLOUR TESTING Note that colour space testing was performed in the monitor's relevant mode (such as sRGB or DCI-P3) if available. If not, we used a 6500K colour temperature. If that wasn't available, we used the default mode. The ideal is for a monitor to achieve 100% sRGB coverage and 100% volume: a big difference between the two values shows the panel isn't tuned to that colour space.

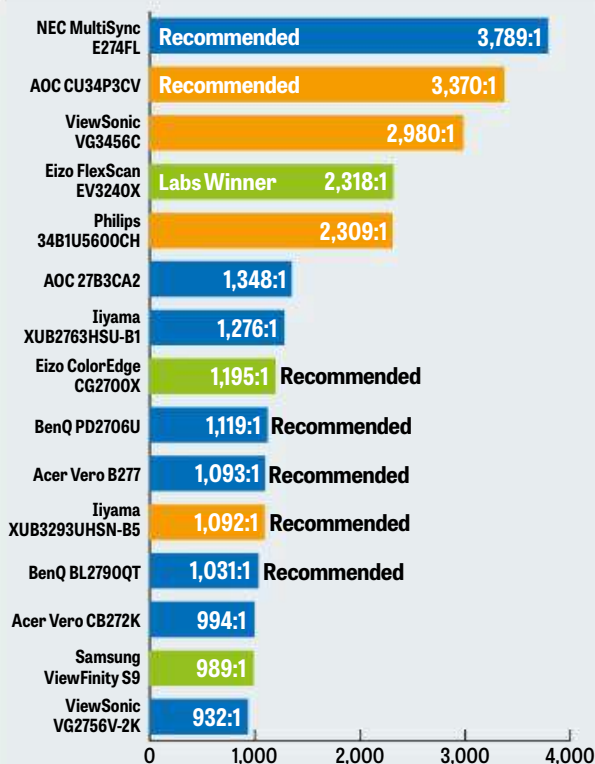


Colour temperature

(against 6500K)

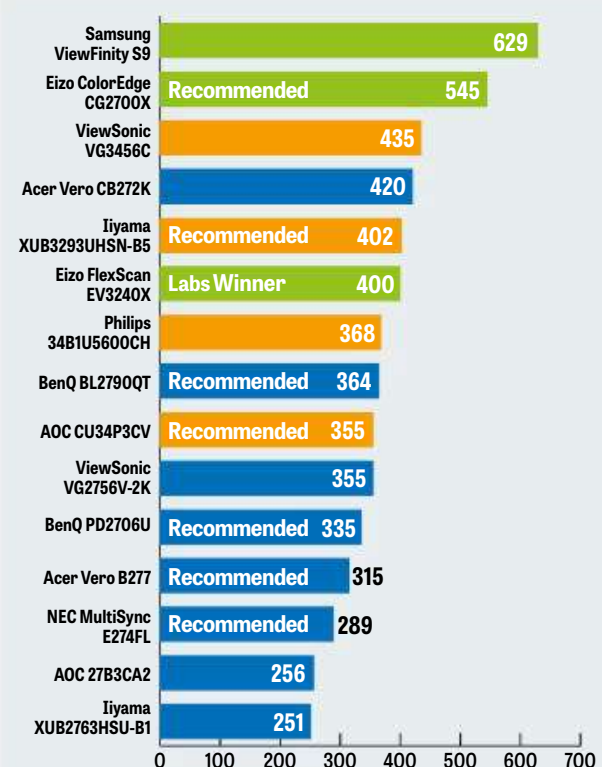


Measured contrast ratio



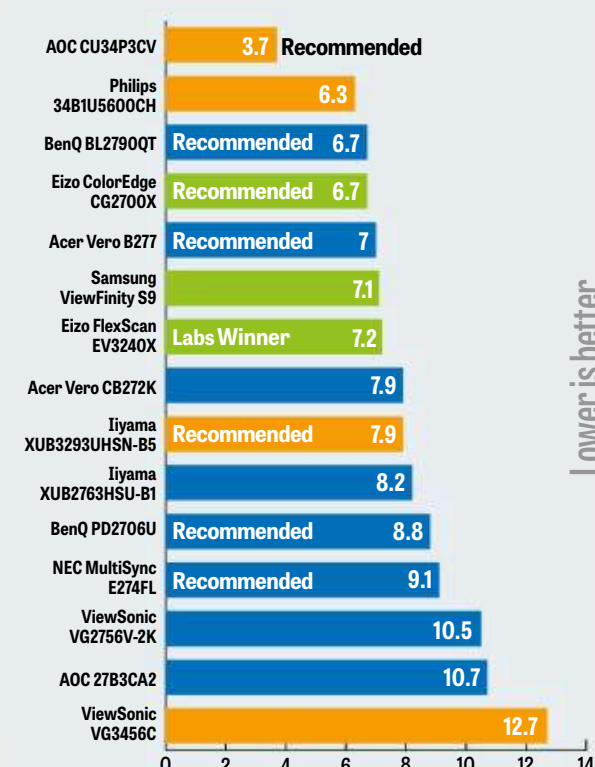
Peak brightness

(cd/m²)



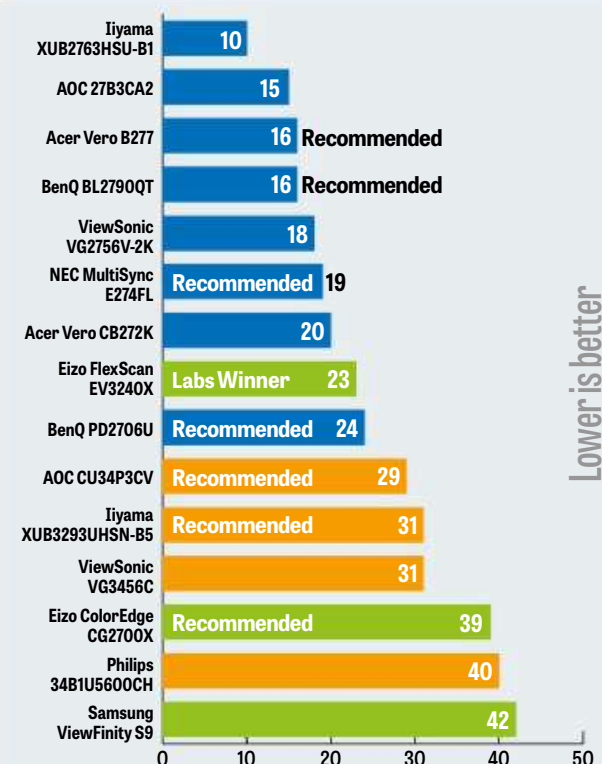
Average brightness variation

(%)



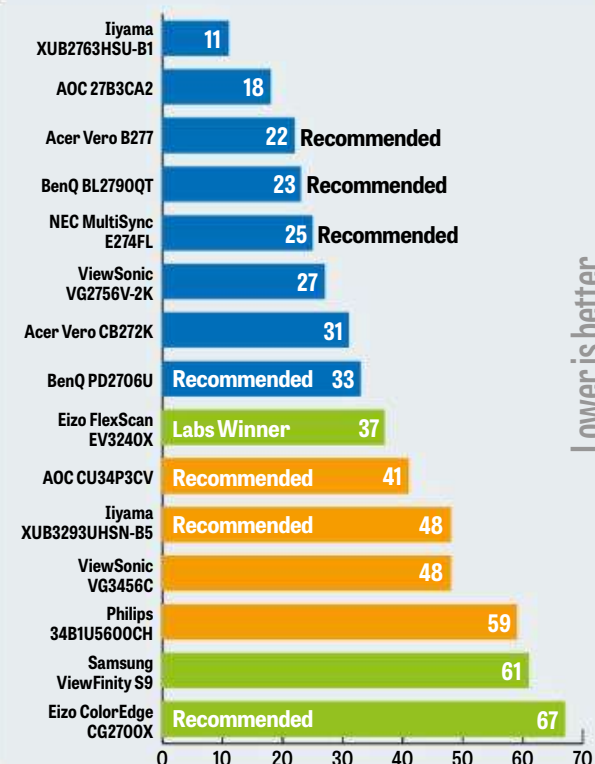
Power consumption at 200cd/m²

(W)



Power consumption at peak brightness

(%)



View from the Labs

Much as I love testing screens, sometimes it's hard to say goodbye

I'm in a privileged position. For some reason tucked deep into my psyche, I love testing new monitors. In this Labs, I've tested 15 very different blighters, and apart from unpacking and packing them (let's not talk about my back), it's been a pleasure.

That's partly because they're all so good. I don't think you would be disappointed if you plucked one at random. Sure, some have better image quality than others, but use them in isolation and they all look great.

The downside of this, from a manufacturer's point of view, is they have fewer weapons to make their screens stand out. I used to see differentiation via the ports. Primarily through USB-C: cheaper monitors never used to include this handy connector, but now it's almost ubiquitous. Almost, but not quite, with three holdouts here. And that makes sense, because not everyone will actually use USB-C, so why pay extra for it?

I can only assume that RJ45 ports, and the associated electronics, have massively reduced in cost. Over half the tested monitors include one this month, and that's a huge change. Three of the monitors include a webcam, too, but I suggest you don't get too excited. A standalone £50 webcam will do a far better job. The same is true of the bundled speakers, too, I'm sorry to say.

I've also noticed another rule-of-thumb disappear. I used to be able to tell whether a panel used VA or IPS tech with a single and dare I say skilful glance – the whites were a particular giveaway. But, just as contrast ratio used to be a great proxy for image quality, you can no longer make quality judgements through such basic measures.

In fact, there's only one rule of thumb that still holds. The more you pay, the better the monitor you buy. Nowhere is this more true than the pair of Eizo screens I tested this month, which blew my little socks off for very different reasons (as discussed in their reviews).

That's bad news for me. I only had the FlexScan EV3240X for three weeks of testing, and may have shed a tear as it was driven away. Maybe I'm not in such a privileged position after all. ●



Tim Danton is editor-in-chief of *PC Pro*, but could quite happily spend all his time testing monitors.

X@timdanton

The Network

Practical buying and strategic advice for IT managers and decision makers

Buyer's guide

VoIP 2024

As VoIP continues to grow in importance, **Dave Mitchell** explains how to ensure you're choosing the right service for your business and reviews four top contenders



Businesses that still haven't made the switch to voice over internet protocol (VoIP) are running out of time. Dubbed "the big switch-off", OpenReach will close down the entire public switched telephone network (PSTN) and integrated services digital network (ISDN) by the end of December 2025.

Some companies think that moving to VoIP is optional, but rest assured that by this date all legacy analogue phone systems still in use will stop working – forever. If you didn't know this, you're not alone. A recent study commissioned by UK internet service provider Gamma and conducted by the Centre of Economics Business Research found that 29% of the 400 UK businesses surveyed were completely unaware of the big switch-off and its implications (see tinyurl.com/357switchoff).

Businesses need to plan their migration soon to ensure all issues are ironed out well in advance.

The good news is that VoIP is a very mature technology with plenty of affordable products already on the market. Compelling reasons for making the switch now include the fact that VoIP offers huge reductions in operating costs, and it's ideally suited to hybrid and working-from-home environments.

VoIP offers cheaper local and international phone call costs, and businesses with multiple offices can reap even more benefits – with the

right system in place, internal calls between them are free. This month, we've reviewed four business VoIP solutions and tested them in the lab to help you make an easy transition to digital communications.

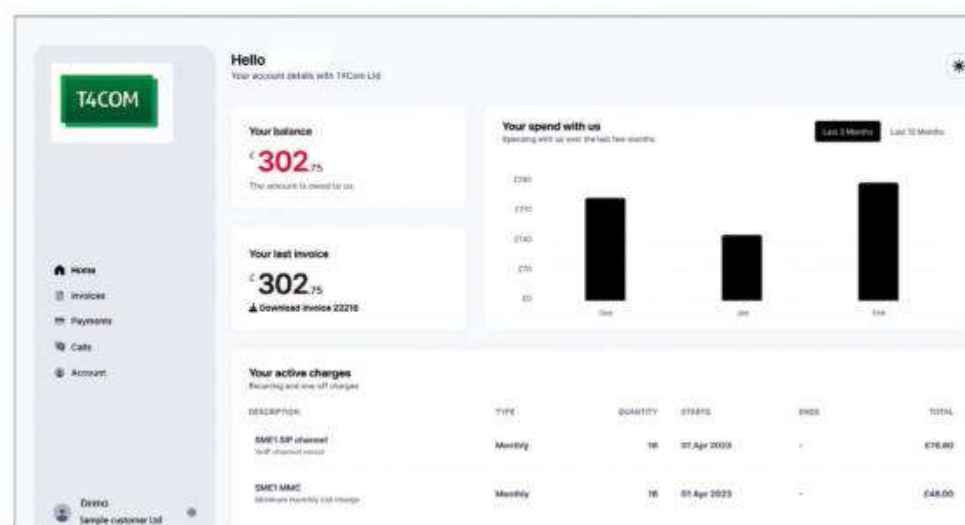
VoIP is in the house

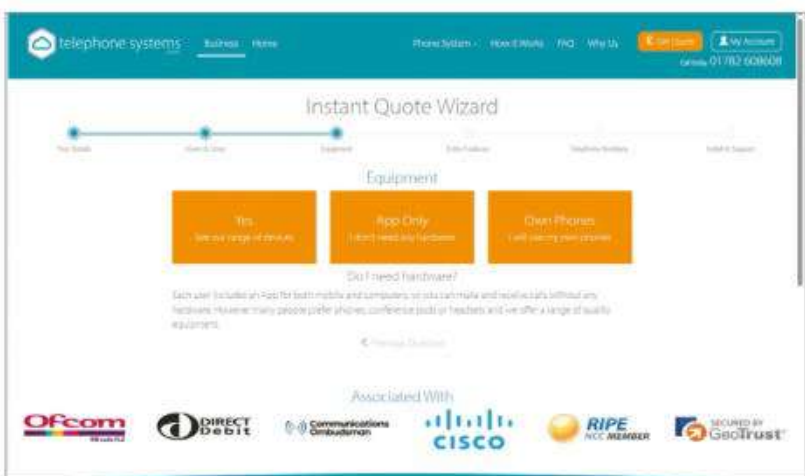
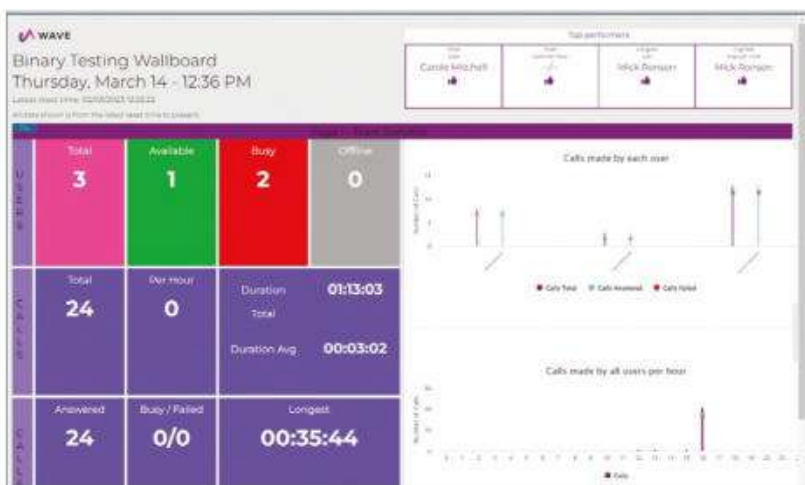
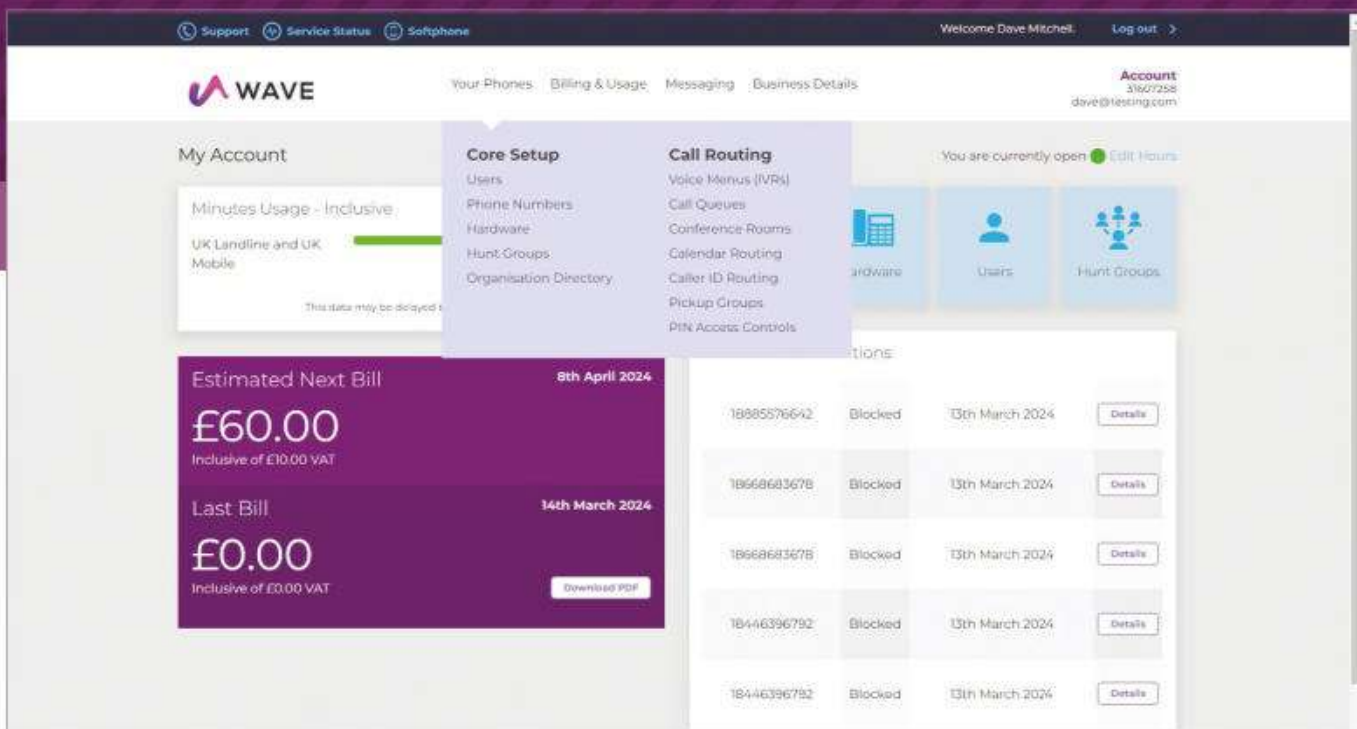
As with existing PSTN services, VoIP also requires a private branch exchange (PBX) system to facilitate services such as inbound and outbound calls, call forwarding and voicemail. However,

unlike PSTN, you have a number of deployment options, as you can run an in-house VoIP IP PBX or have it hosted by a service provider.

An in-house IP PBX will cost a lot less over the long term than a hosted service and it gives you full control over voice services and access security. Setting it up requires

BELOW To test the IP PBX we used the excellent SIP trunk services from UK company T4Com





affordable, and T4Com offers full redundancy as it owns and operates its own infrastructure, which is mirrored across two data centres.

Cloud connected

SMBs who are unsure about maintaining their own VoIP system will find a solution run by a managed service provider requires far less technical expertise. It will cost more over time, but there are a rapidly increasing number of

ABOVE Gradwell's Wave admin portal provides easy access to all users and call features

LEFT Gradwell's wallboard view shows the status of users and calls

LEFT Telephone Systems' online quote service lets you see future costs

some technical knowledge, though, as it's far from plug and play.

A self-managed cloud IP PBX is a great alternative as it does away with any requirements for software installation and on-premises hardware. One VoIP solution we've reviewed gives you the best of all worlds: you can run it on-premises, in your private cloud or let the vendor host it in their own cloud.

Either way, you'll need a session initiation protocol (SIP) trunk to route VoIP calls over the public network. Prices are generally based on the number of call lines, or channels, you require. A good starting point is to purchase one SIP channel for every three users.

To test the self-managed VoIP system, we use the SIP trunk services from T4Com Ltd (t4com.co.uk). Monthly costs per channel are very

VoIP providers to choose from so you can pick one that fits your requirements and budget.

Good providers can shoulder the deployment load by assigning an account agent to handle the entire VoIP provisioning process. You won't need to worry about SIP trunks, as these are included and, in most cases, are completely transparent.

Cloud hosting companies offer a wide range of call plans, with the most basic pay-as-you-go options incurring a fixed monthly fee per user and charging your account when calls are made to landlines and mobiles. This is a good starting point if you're unsure of future usage, but big savings can be made by opting in to plans that charge a monthly fee for a specific number of call minutes.

You can reduce costs further by signing up for yearly contracts rather

than paying per month. Your requirements will almost certainly change during these longer periods, so check that you can upgrade or downgrade a plan at short notice.

Call plans

Costs for in-house systems and cloud-hosted VoIP services will vary depending on the call features you want. It's worth doing plenty of research first as you may find some are only available with advanced plans or enabled as optional extras.

Business VoIP services can present a digital front desk to customers, with auto-receptionists or interactive voice response (IVR) systems providing callers with a custom menu of options. This exudes professionalism, as callers can be handled efficiently and always directed to the right person.

Hunt groups mean never missing an incoming call again. All users assigned to them can have their phones ring together or in strict rotation. Call queues will help during busy times as they present callers with reassuring messages and on-hold music, with the best ones advising them of their position in the queue.

Videoconferencing (VC) grew exponentially during the pandemic, and many VoIP providers have integrated these features into their services so you don't need to pay for a separate product. Not all providers offer VC services, and some are still in

"VoIP offers huge reductions in operating costs, and it's ideally suited to hybrid and working-from-home environments"

the process of developing them, so we recommend checking them out first.

Businesses can't afford to ignore the big switch-off any longer as they have a maximum of 18 months to complete their

move from PSTN to VoIP. Doing it now means you'll have time to find the best system or provider for your needs and even more time to make sure it's working perfectly.

There's no time like the present to make the move to VoIP. It's a painless process that offers massively reduced costs and professional call-handling features that will give your business a competitive edge. Turn the page to see which cloud-based or self-hosted VoIP solution is best for your business – and if you're already using VoIP we salute you, but you may just find one offering a better deal than your current provider.



3CX Phone System V20

The best IP PBX gets even better with a new admin console, tighter security and a wealth of affordable options

SCORE ★★★★★

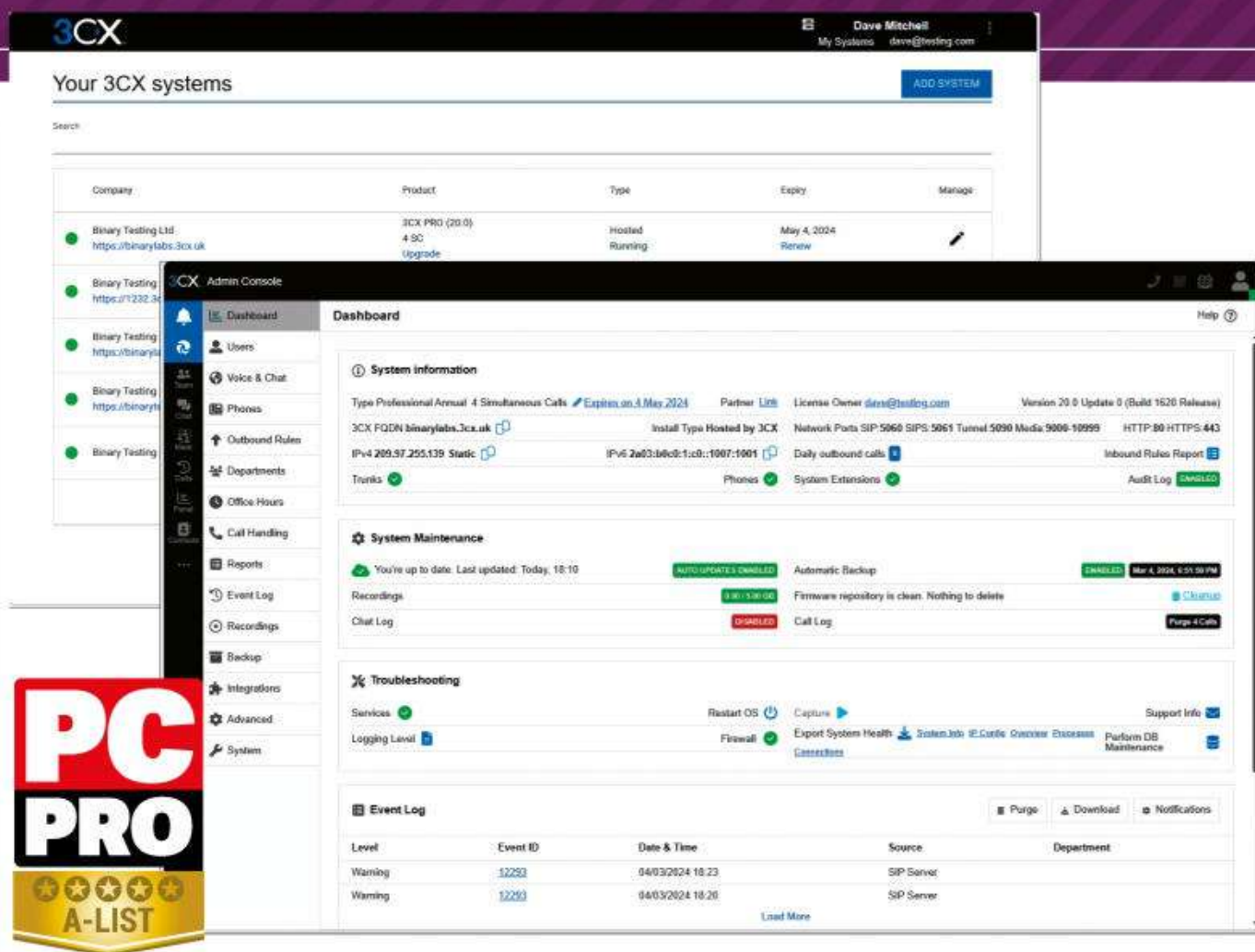
PRICE Small Business, 10 users, £175 exc VAT per year from 3cx.com

3 CX is the place to go for the best IP PBX services, as its Phone System software offers an unbeatable range of call-handling features. Not content to rest on its laurels, 3CX has been working hard on development and the version 20 on review represents the most significant update we've seen for many years.

Security takes centre stage here, with 3CX hardening its systems against cyberattacks by using a zero trust model across the board for much stricter access control policies. Only allowing the native 3CX softphone app to be deployed from the Microsoft store adds extra security, and it lets 3CX update it as required without having to tinker with the main Phone System build.

One of the biggest changes is with the admin console. Previously, there was a separate management interface, but this has been redesigned and integrated into the client app so admins don't need separate consoles to use and manage the system.

Phone System is available in four plans, with the 3CX Free cloud-hosted edition aimed at micro businesses with up to ten users. The Small Business edition, also cloud-hosted by 3CX, supports up to 20 users and starts at £175 per year, while the Professional and Enterprise editions increase the number of features



hugely and can be run on-site, in a private cloud or hosted by 3CX.

For this early review, Phone System V20 was only available for Debian Linux 12 so we chose to virtualise it on the lab's Windows Server 2022 Hyper-V system. Deployment was undemanding; we assigned the downloaded ISO file to a new VM, booted it up and followed the brief Debian install wizard, which finished by loading Phone System and providing a link to its web console.

The new client interface will be a big surprise for existing users as the dashboard's system performance graphs and quick access icons have been removed to make way for far more information about the Phone System status, configuration and event logs. All admin features are still easily accessible from the left menu, and a sidebar next to it provides direct access to calls, chats and voicemail, with icons to the top right provided for one-click links to a dial pad and availability status settings.

ABOVE The new 3CX portal provides lots of information about your IP PBX

“Security takes centre stage here, with 3CX hardening its systems against cyberattacks by using a zero trust model”

BELOW Admin functions and call handling are all neatly integrated

There are some on-premises prerequisites, as you still need to create forwarding rules on your firewall for Phone System's SIP and RTP port ranges. The system's fully qualified domain name (FQDN) must now be resolvable internally and externally so your firewall needs to support split DNS, but smaller businesses can make all these issues

disappear by opting to let 3CX host Phone System V20 in the cloud.

You'll need a paid-for SIP trunk to enable VoIP calls; we used the excellent UK-based T4com Ltd, which is

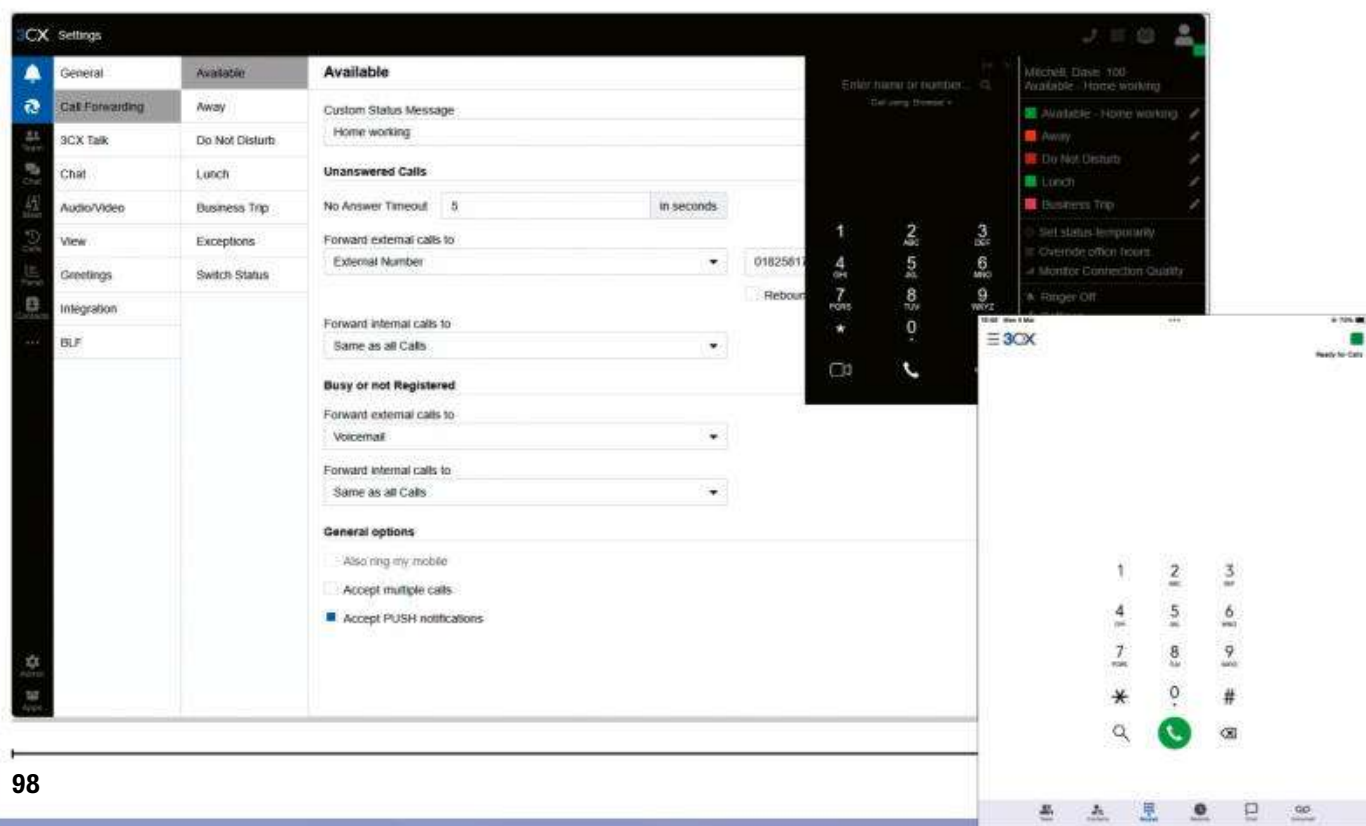
on 3CX's supported provider list. Adding the trunk was simple: after entering the main trunk phone number, account and password, it was ready for action in one minute.

Adding new users and provisioning IP phones is just as easy as with previous versions, while ring groups, call queues and a digital receptionist ensure calls are never missed. Call forwarding allows users to redirect calls when they're working from home, and 3CX has added 2FA user authentication plus integration with Microsoft 365, Google Workspace and a host of CRM apps.

3CX Phone System V20 is our recommended choice for businesses that want to manage their own VoIP system. Available in a range of affordable plans, it can be hosted in the cloud or on-premises, and this latest version adds an impressive range of new features.

REQUIREMENTS

On premises: Windows 10 Pro/Enterprise • Windows Server 2016 upwards • Debian Linux 12 • Raspbian (SBC only)



Gradwell Wave

A classy cloud-hosted VoIP service with easy deployment, great call handling and affordable call packages

SCORE 

PRICE Wave 100 from £7.50 exc VAT per user per month from gradwell.com

UK-based Gradwell has been in the communications business for over 25 years, and its Wave cloud VoIP service will appeal to SMBs seeking a smooth transition from their legacy analogue systems. Deployment is a breeze. Gradwell manages the process for you, and pricing is easy to understand as you only need to concern yourself with the number of monthly call minutes to landlines and mobiles that you require.

Wave comes in three packages, and they all offer the same call-handling features along with the Wave desktop and mobile apps. The Wave 100 package costs £7.50 per user per month and provides 100 monthly call minutes; Wave 1000 starts at £10.50 and allows 1,000 minutes; and Wave 3000 costs from £15 and, you've guessed it, offers 3,000 minutes.

Reliability is assured since Gradwell hosts Wave on Amazon Web Services (AWS) and will create new instances as needed to cope with increased demand. Redundancy is covered, too, with Wave being deployed across three geographically diverse AWS sites.

Gradwell handles all on-boarding by creating your main admin portal account, assigning phone numbers

and adding a base set of users if you've requested them. Desk phones can be added to your order and will arrive pre-registered to your account so you only have to plug them in.

The Wave administration portal presents an account usage overview and provides easy access to all the core features and call-routing services. To add new users, you simply enter an email address to send their invitation to, set a password and decide whether to give them admin privileges or just make them Wave users.

Direct inbound dial (DID) numbers and available desk phones can be assigned to each user, and you have options to enable voicemail, activate inbound and outbound call recording and set up call diverts to an external number or another Wave user. Multi-factor authentication can be enabled, and when users activate their account they receive a personal web portal and download links for the Windows, macOS, iOS and Android softphones.

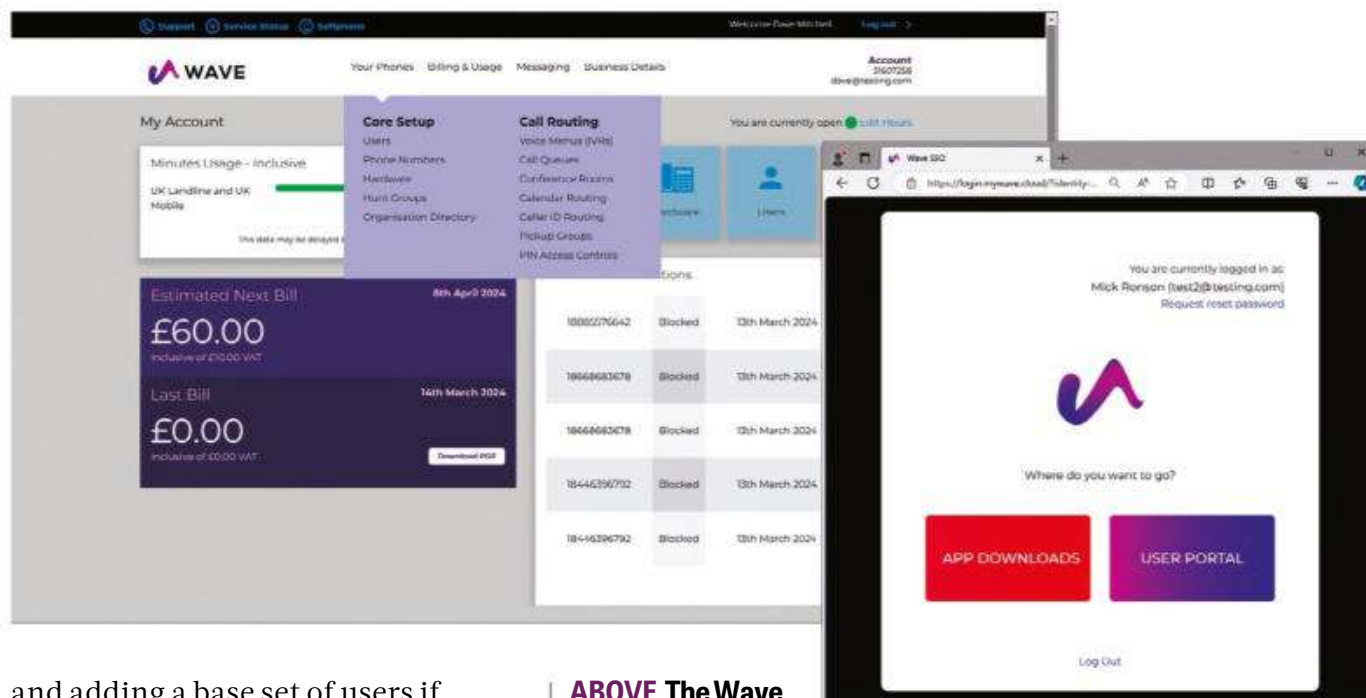
The Wave user portal is a simple affair, with options to withhold their outbound CLI, access voicemail, assign busy lamp fields (BLFs) to their desk phone screen menus and view a

ABOVE The Wave admin portal keeps you posted on ongoing costs



“Reliability is assured since Gradwell hosts Wave on AWS and will create new instances as needed to cope with increased demand”

BELOW Wave includes softphones for all of the most popular platforms



contact list. A softphone is required to make and receive calls, and we had no problems installing it on Windows 10 and 11 desktops along with iPads.

The softphone offers the same features as the web portal and adds a dial-pad, a recent call list and access to settings such as notifications and sounds. Gradwell removed videoconferencing from the softphone a couple of years ago, and this is now handled by its separate Teams+ service, which costs £2.50 per user per month and allows users to make and receive calls and run VC

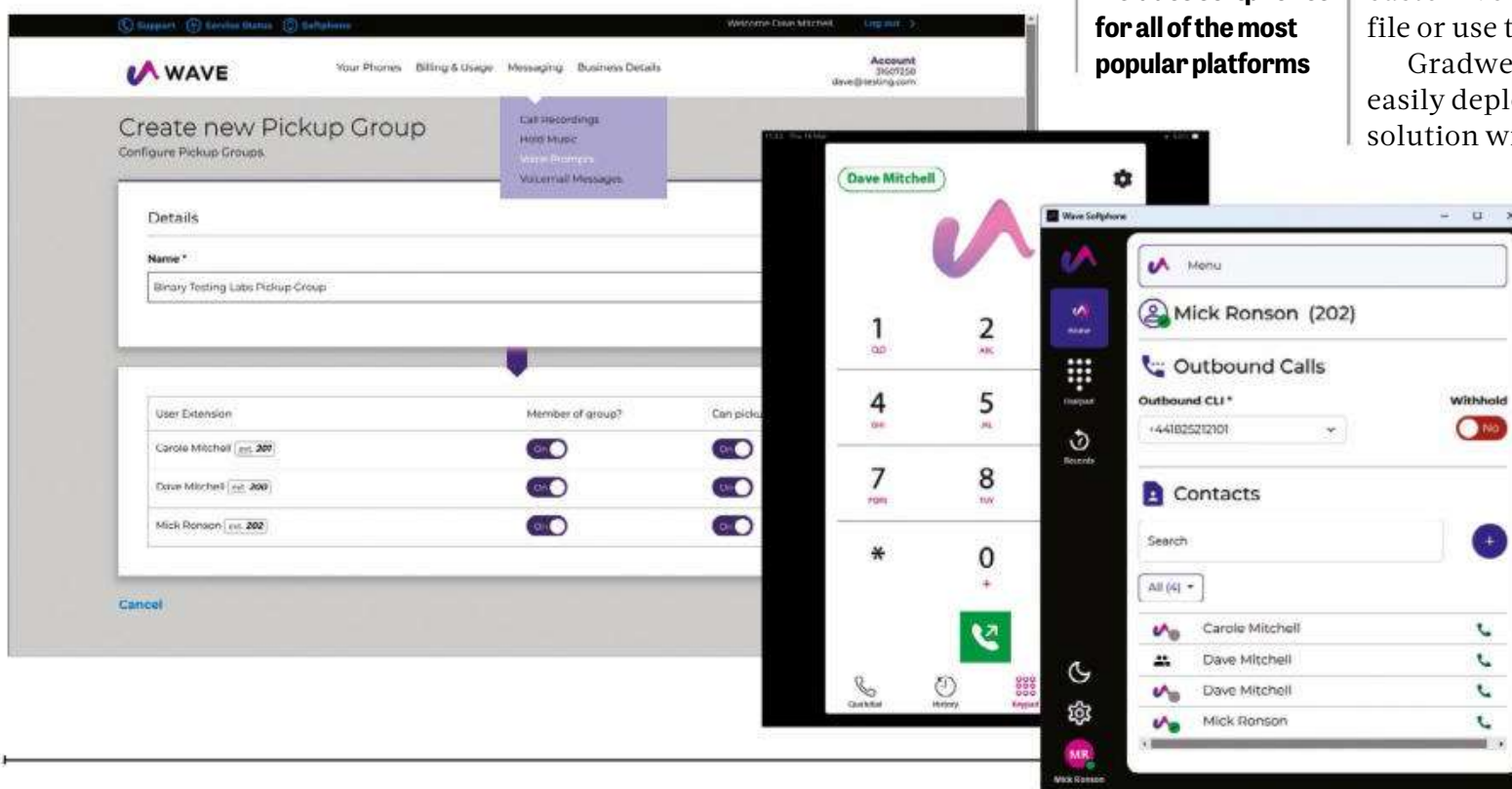
sessions directly from the Teams desktop app.

As you'd expect with such a mature product, call-handling features are abundant and include hunt groups with multiple routing steps,

call conferencing, pick-up groups and automatic routing based on calendars or bank holidays. Call queues advise callers that they'll be recorded, play music on hold and present them with a range of custom messages, while Wave's interactive voice response (IVR) service allows you to record custom voice prompts, upload a WAV file or use the Wave default prompts.

Gradwell's Wave provides an easily deployed cloud-hosted VoIP solution with sophisticated call

handling features. Its flexible price plans are very affordable, and micro-businesses will find Gradwell's new PSTN replacement bundle appealing as this starts at £9.50 per month and provides everything you'll need, including a broadband connection, for a pain-free move to VoIP.





TelephoneSystems.Cloud

A smart business VoIP-to-go service that's easy to order and use, and is packed with great call-handling services

SCORE ★★★★★

PRICE From £11 exc VAT per user/month from phonesystems.cloud

TelephoneSystems.Cloud stands out from the crowd of VoIP providers as its automated quote system lets you set your entire business service up without having to speak to any representatives. We tested this by visiting the main website (given away by the company name) and clicking on the “Get Quote” button, after which we were guided through a set of questions asking about our requirements.

For our VoIP testbed, we requested four users, chose to use our own internet provider, opted for softphones and our existing desk phones, skipped the optional Webex Teams+ and Presenter, asked for new UK phone numbers and selected the automated installation service. TelephoneSystems.Cloud presented us with an itemised bill showing a £60 setup fee and monthly charges of £11 per user, which we agreed to by completing the transaction with our banking details and setting an admin account password.

You're nearly there now; the next web page asks for a preferred area code, details of the services required such as call groups and queues, plus auto-attendants and the MAC addresses of existing desk phones. Lastly, you add details of

your users, provide passwords and choose their extension numbers.

On completion, we received an email and SMS advising us the account was being created. It was ready for action two hours later, and at no time during this process did we speak to anyone.

From our account dashboard, we saw that all our users had already been assigned a direct inbound dial (DID) number from the block we'd requested. Onboarding is simple: you issue an email invitation from the dashboard that provides a link to the Webex client and mobile apps, along with instructions on setting them up.

After installation, users sign in with the Webex email address and password the system assigned to them and they're ready to start making and receiving calls. This is the standard Webex app so it offers plenty of useful features, including personal contact lists and a quick access dial pad. Integral videoconferencing lets users make video calls with consummate ease.

Pre-configured desk phones can be ordered online, with choices including Yealink, Jabra and Polycom. For our own Yealink T42S

ABOVE The order process and the admin dashboard are both very slick



“An incredible range of call-handling services are available and include an auto-attendant, call centre, call parking and much more”

models, instructions were emailed to us so we just entered the supplied provisioning URL in their web consoles and, after a firmware upgrade, they were automatically assigned to each user.

Voice prompts for services such as the auto-attendant, voicemail, holiday greetings and on-hold messages can be added, and TelephoneSystems.Cloud goes a step further than many providers with its AI text-to-speech service, which costs £10 per message. Alternatively, you can upload your own audio files to an online library, and the company even offers professional voice actors

to create them for you, with online quote services provided.

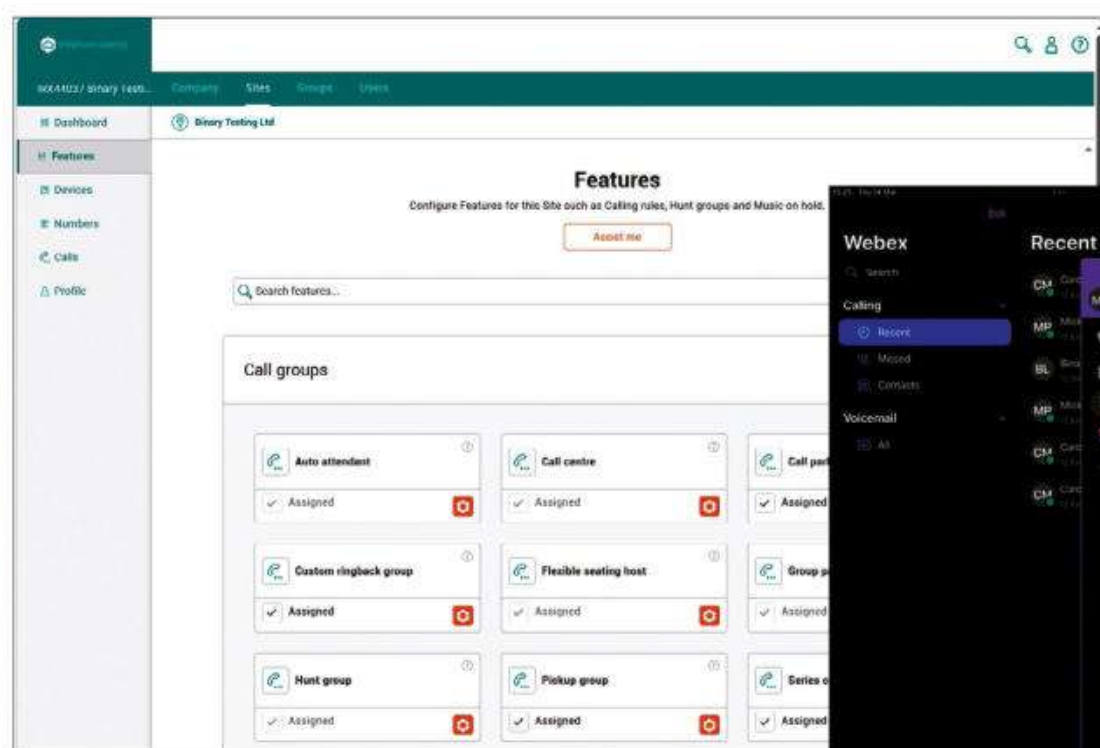
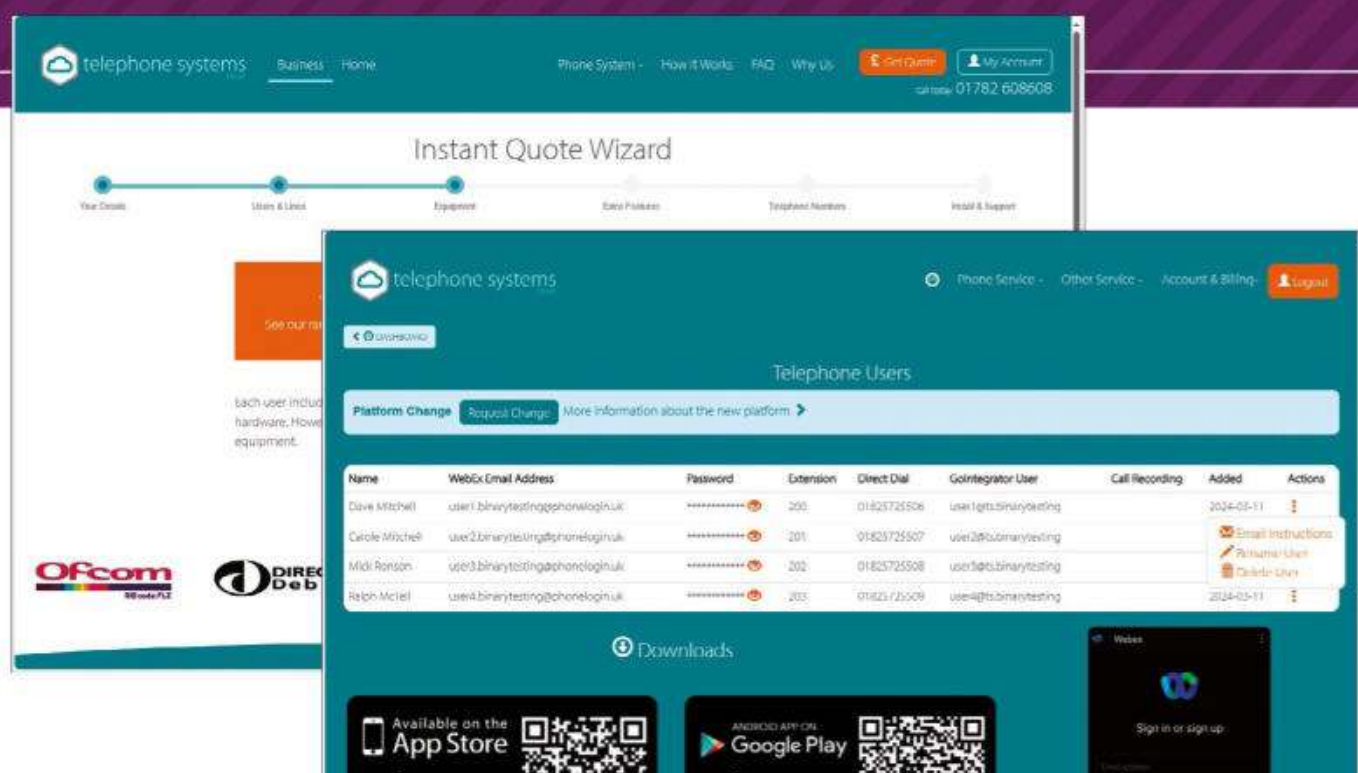
The dashboard presents plenty of account information and a call history graph for the past six months, while

the billing section keeps you posted on the latest invoices and upcoming payments. All the action takes place in the account portal, which lists your sites, assigned numbers, all users and associated devices such as desk phones and mobile apps.

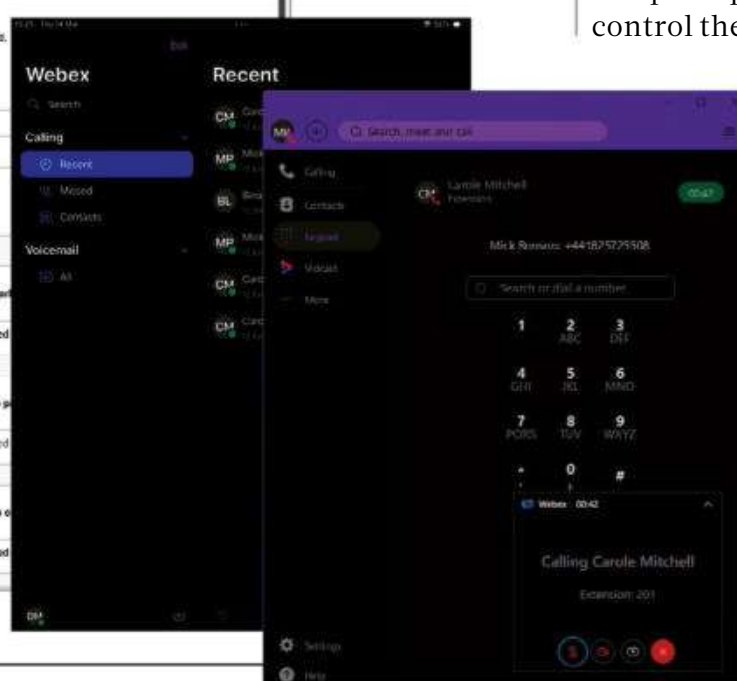
An incredible range of call-handling services are available and include an auto-attendant, call centre, call parking, groups for ringback, hunt and pickup and much more. Rules control the numbers and countries to

which outbound calls can be made, while group contacts are synced to Webex so they appear in the apps.

TelephoneSystems.Cloud is a great choice for businesses that know what they want from cloud-hosted VoIP services. The quote process is impressively smooth, and it offers a wealth of easily accessible call features at a competitive price.



BELOW The Webex app supports audio and video calls



VoIP8

No need to worry about moving to cloud-hosted VoIP: this company does all the hard work for you

SCORE 

PRICE From £10 exc VAT per extension/month from voip8.uk

SMBs fretting about the transition to digital communications can rest easy with VoIP8, as this UK-based cloud provider aims to demystify and simplify the entire process. Whereas many providers expect you to know what you want before signing up, VoIP8 will discuss your needs first, tailor a system to your requirements, guide you through deployment and provide ongoing management and support.

VoIP8 is transparent about pricing so there are no hidden costs, and it all looks very affordable. Each extension and external number costs £10 and £5 respectively per month, the price includes all calls to UK numbers and there are no fixed-term contracts.

To test VoIP8, we had the obligatory conversation with its support staff and opted to start with five extensions, or seats, and one external UK phone number with the option to add more later on. You choose your preferred area code and, where possible, VoIP8 will port existing numbers across to the service.

An introductory email came in a minute later with a link to create our VoIP8 portal account. The interface opens with a “client area” that

provides an overview of account details, the services ordered and a list of assigned extensions.

This is where VoIP8 differs from many other providers, as you don’t have any access to VoIP settings. The whole point of this service is that VoIP8 makes all agreed changes in its secure backend systems for you.

If you want call-handling services such as auto-attendants, call queues, call recording, ring groups, hunt groups and so on, that’s no problem because VoIP8 will configure them for you. That said, it’s planning on launching a customer portal so you can tweak some services without calling its support team.

New services are ordered directly from the portal, with additional extensions and phone numbers requested with one click. A choice of three VoIP desk phones is available. These are delivered preconfigured so you just plug them in and wait for them to auto-provision and link up with the designated extension.

VoIP8 maintains its own provisioning servers and can bring your existing desk phones into the fold. We tested this with a spare

ABOVE The VoIP8 web portal provides access to your main account



“The whole point of this service is that VoIP8 makes all agreed changes in its secure backend systems for you”

BELOW The portal provides downloads links for the Zoiper desktop and mobile softphone app

Yealink T58 desk phone and, in a remote support session lasting less than a minute, the technician provisioned the phone and assigned it to our nominated extension.

The portal offers softphone download links. VoIP8 employs the popular Zoiper desktop and mobile apps, although these are only the free feature-restricted community versions. Even so, they’re easy to deploy; the Windows version is preconfigured for the selected extension, while an iPad was provisioned by scanning the QR code on the download page.

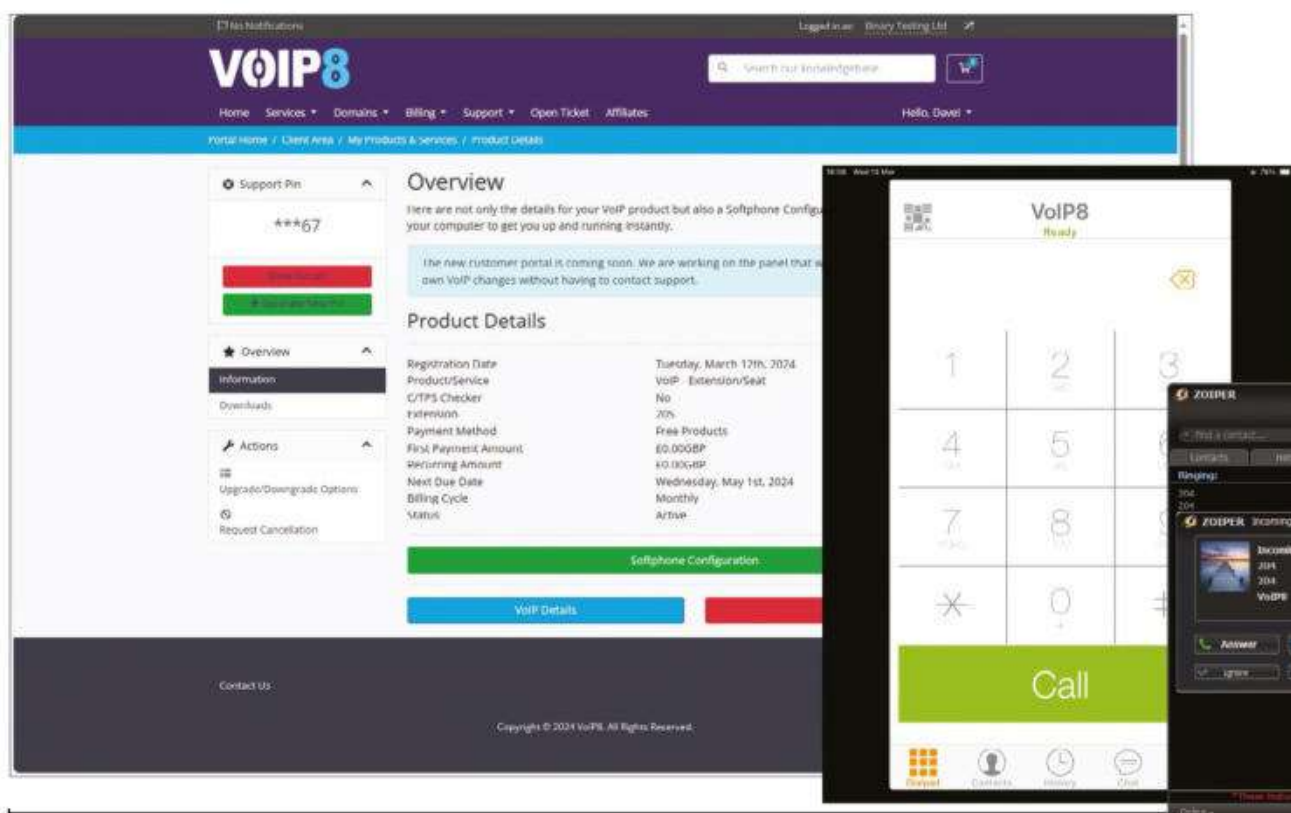
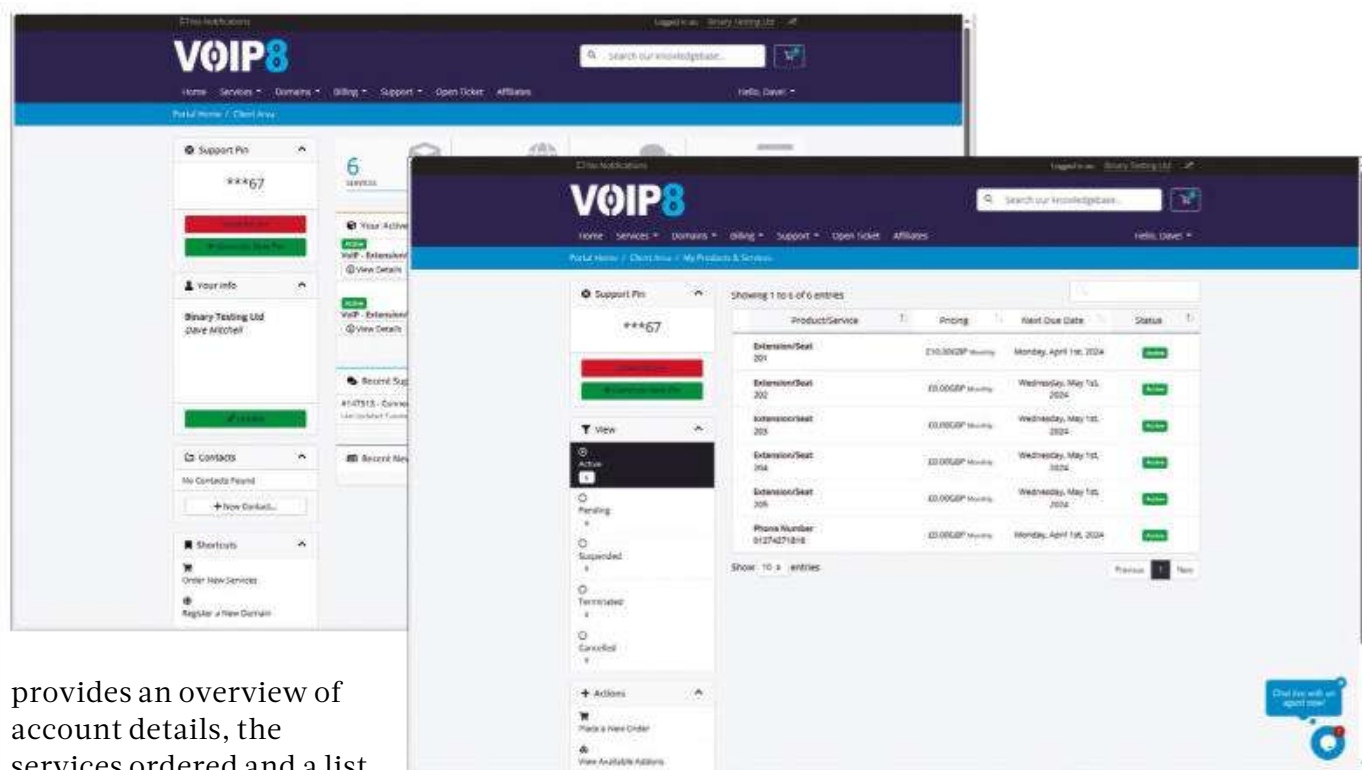
VoIP8 currently maintains all call logs in-house and can send them to you on request – they’ll soon be available in the account portal. It also

securely stores all call recordings on its servers for six months and can supply them on request.

You can keep a close eye on costs from the portal, with its billing section showing all paid and outstanding invoices. The main account page provides a full audit of all email communications with VoIP8, along with one-click access to the message contents.

For account management, you can add extra users and decide which roles they are allowed to perform. There are 13 roles available and include full account access, ordering new services, paying invoices and opening support tickets.

VoIP8 is a strong contender for SMBs seeking a pain-free migration to VoIP. The company does all the heavy lifting for you, can customise call services precisely to your needs and all at a sensible price.





WatchGuard FireboxV Micro

Small in price and big on features, the FireboxV Micro delivers virtually perfect network perimeter security

SCORE ★★★★★

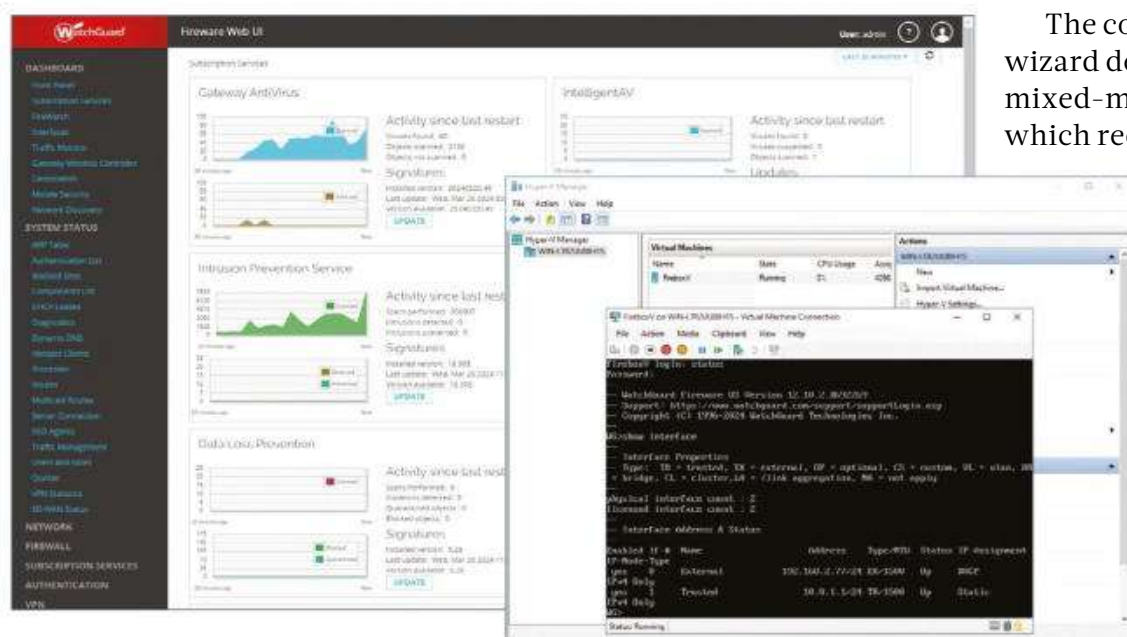
PRICE 3yr TSS subscription, £2,204 exc VAT from watchguard-online.co.uk

WatchGuard's FireboxV will appeal to businesses that want to virtualise their security services and avoid the extra cost of an on-premises hardware appliance. It's now available in five versions, after WatchGuard responded to customer requests and added a budget-priced Micro model.

Targeting smaller sites with up to five users, FireboxV Micro is restricted to two virtual CPUs (vCPUs), a maximum firewall throughput of 1Gbit/sec and five branch office VPNs. If your needs change in the future you can upgrade to a Small, Medium, Large or XLarge model by applying a new licence key, and there are no compromises on features: all versions offer precisely the same security measures as WatchGuard's hardware appliances.

FireboxV supports Hyper-V, VMware plus KVM on CentOS. For testing, we installed it on a Dell PowerEdge R650xs rack server running Windows Server 2022 and the Hyper-V role. It's a simple process: we downloaded the virtual disk, created a new VM with two vCPUs and assigned two virtual switches for external WAN and trusted LAN connections.

Initial appliance and security policy configuration is aided by a browser-based wizard. During this phase, you can opt to retain the



The configuration wizard defaults to mixed-mode routing, which requires each internal LAN port to be defined as a separate interface. All FireboxV versions support up to ten virtual interfaces so you can add extra ports and extend protection to

local web console and send the appliance's activity logs to your WatchGuard cloud portal account. Alternatively, you can enable full cloud management, which disables the local interface and provides remote access to all appliance configuration settings.

WatchGuard keeps things simple by offering two licensing options, and we've shown the price for a three-year Total Security subscription. This enables every security service WatchGuard has to offer, including gateway antivirus, anti-spam, web content filtering, application controls, intrusion prevention services (IPS) and an advanced persistent threat (APT) blocker with cloud sandboxing.

In addition, TSS activates WatchGuard's RED (reputation enabled defence) cloud-based URL filtering, ThreatSync XDR for collection, correlation and automated responses to threat events, and DNSWatch to monitor client DNS requests and block access to known malicious domains.

FireboxV Micro requires a minimum 2GB of virtual memory, but we gave ours the recommended 4GB so we could enable the Cylance AI-based IntelligentAV malware scanning engine and use WatchGuard's full signature set for the IPS and application control services.

ABOVE FireboxV Micro is simple to deploy on Hyper-V and very easy to manage



"You can enable full cloud management, which disables the local interface and provides remote access to all appliance settings"

different network segments.

The local web console provides easy access to all security policies and functions, but we decided to go fully cloud-managed by registering the appliance with our support account, allocating it to our site and choosing the management and monitoring option. The process is different to the hardware appliances: we had to reset our FireboxV back to factory defaults, run through the wizard again and upload the encrypted payload file created when we registered it with our cloud account.

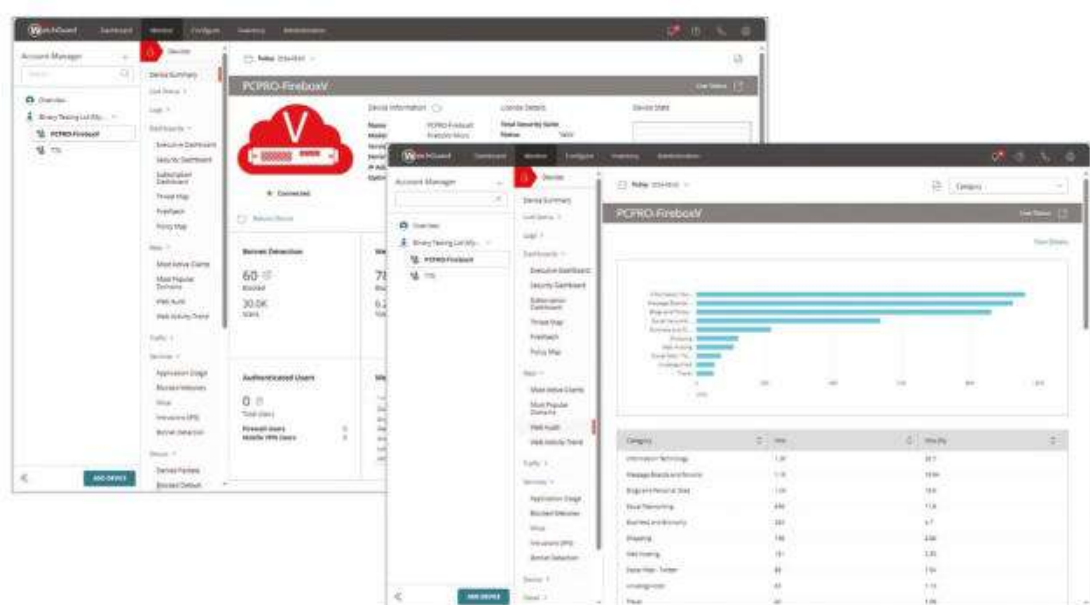
It took only five minutes to complete, after which the FireboxV disabled its local web interface, took all further settings from the cloud and provisioned full access for remote configuration. All security functions are easily accessible and from the

portal's content scanning page, you use slider bars to enable the gateway AV, IntelligentAV, APT blocker and spamBlocker services.

Anti-spam policies are available for SMTP, IMAP or POP3 traffic where you allow, deny or tag spam messages in their subject line for ongoing local rule processing. From the network blocking section, you can control botnet detection, IPS, custom blocked URLs and ports plus detection of Tor (The onion router) exit points. WatchGuard's application control service presents over 1,250 predefined app signatures, while web content filtering offers 130 URL categories for blocking or allowing.

WatchGuard's FireboxV Micro is ideal for SMBs that want to virtualise all their network protection. It's a cinch to deploy, supports local or cloud management and delivers an incredible range of security measures at a very affordable price. **DAVE MITCHELL**

LEFT WatchGuard's Cloud service offers remote configuration and monitoring



REQUIREMENTS

Windows Server 2019 Hyper-V • VMware ESXi 6.5 • KVM on CentOS 8.1 upwards

Zyxel WBE660S

The WBE660S sets a high bar for Wi-Fi 7 performance and delivers great features and smart cloud management

SCORE ★★★★★

PRICE £569 exc VAT
from broadbandbuyer.com

Consumers have had it all their own way for far too long: this year, at last, the Wi-Fi 7 focus is going to shift significantly towards businesses. Zyxel gets the ball rolling with two business Wi-Fi 7 access points (APs), and we reviewed its flagship tri-band WBE660S.

This solidly built BE22000-rated AP has a lot to say as it presents 12 spatial streams – four each for its 2.4GHz, 5GHz and 6GHz bands, with theoretical maximum speeds of 1,376Mbps/sec, 8,646Mbps/sec and 11,530Mbps/sec respectively. It supports the Wi-Fi 7 6GHz high-speed 320MHz channels, its main 10GbE port requires an 802.3bt PoE++ power source and its extra gigabit LAN port can be used to network other wired devices.

The AP can be wall- or ceiling-mounted and its smart antenna array automatically detects the orientation and dynamically adjusts the antennas to improve coverage and performance. The finned metal backplate acts as a passive heatsink, and the AP's 1.4kg weight is ably supported by the sturdy metal bracket in the box.

The WBE660S can be deployed in standalone mode or cloud-managed using Zyxel's Nebula Control Center (NCC) platform. Zyxel adds extra cloud appeal as the price includes a one-year NCC Professional Pack

licence, which enables features such as email alerting, scheduled firmware updates and a rolling one-year log retention service.

Installation in standalone mode is aided by the AP's web console wizard, which guided us through setting the country of operation, changing the default admin password and creating radio profiles for the three bands, with the 320MHz channels enabled on the 6GHz radio. The Wi-Fi 7 multiple link operation (MLO) feature isn't currently supported, but you won't have to wait long as Zyxel advised that this will be implemented in the next v7 firmware upgrade.

For our real-world speed tests, we called up a Dell Windows 11 Pro workstation equipped with a TP-Link Archer TBE550E BE9300-rated Wi-Fi 7 PCI-E adapter card. The AP was connected to a Zyxel XS1930-12HP 10GbE multi-gigabit PoE++ switch, and we hooked up a Dell PowerEdge R650xs Windows Server 2022 host to one of its fibre 10GbE ports.

After connecting the workstation to the AP's SSID, we saw that the LED array in the Archer's antenna base was cycling through its colour spectrum, confirming that a 320MHz link was in action. Checking the

workstation's network properties showed we had a 6GHz Wi-Fi 7 connection and a link speed of 4Gbps/sec.

Performance is outstanding, with large file copies between the client and server returning average close-range speeds of 308MB/sec,

dropping to an equally impressive 275MB/sec with the AP placed ten metres away in an adjoining room. This is substantially faster than Wi-Fi 6E with our tests on TP-Link's top-performing Omada EAP690E HD AP returning close range speeds of 233MB/sec.

Swapping the WBE660S to our NCC account was a breeze. We used the Nebula iOS app on an iPad to scan the QR code on its base and choose the site from which it should take its settings. The portal presents an informative dashboard, with customisable widgets showing the status of all Zyxel cloud-managed devices, total wireless traffic, APs by usage, and all connected wireless clients along with their detected OS

and PoE consumption for our Zyxel switch.

Up to eight SSIDs per site are supported, each with their own encryption key, and tags are used so that SSIDs are only

broadcast by APs that have a matching tag. For the 6GHz radio you can enable the 320MHz channels and enforce the mandatory WPA3 encryption in your SSIDs, while for guest wireless networks, custom captive portals with their own logos and messages can be presented and L2 isolation enforced so guests only get internet access.

Considering the WBE660S is one of the first business-class Wi-Fi 7 APs to market, its sub-£600 price tag won't upset early adopters. This superbly built AP delivers a wealth of features, great cloud management services and Wi-Fi 6/6E-busting performance. **DAVE MITCHELL**

SPECIFICATIONS

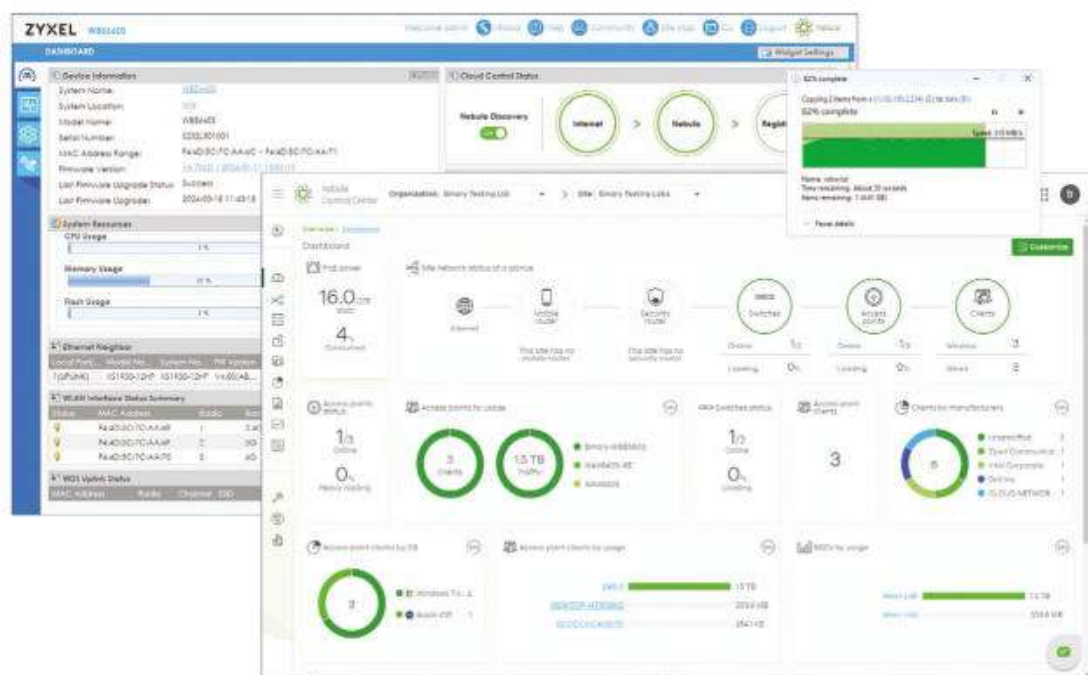
BE22000 tri-band 2.4/5/6GHz 802.11be • 4x4 MU-MIMO • 12 x internal aerials • 10GbE multi-gig LAN/802.3bt PoE++ • gigabit LAN • 12V DC power input (adapter not included) • ceiling/wall mounting plate • 310 x 178 x 56mm (WDH) • 1.4kg • 1yr NCC Professional Pack licence included • 5yr hardware warranty



ABOVE Zyxel's solidly built Wi-Fi 7 access point delivers superb Wi-Fi 7 performance



“Performance is outstanding, with large file copies between the client and server returning average close-range speeds of 308MB/sec”



LEFT The WBE660S can be managed in standalone or NCC cloud mode



How to earn Cyber Essentials certification



The UK's government-backed security standard provides reassurance for you and your customers. **Nik Rawlinson** explores what's involved – and how to get it

If your business has any kind of internet connection, it's at risk. In a recent survey by Deloitte, a full third of executives said their accounting and financial data had been targeted over the past 12 months; in 2022, an incredible three-quarters of organisations polled reported that they'd been the subject of an attempted ransomware attack.

And things are unlikely to get any better any time soon. As AI and machine learning go mainstream, the potential for malicious actors to cause harm is only increasing. Your organisation must be ready to defend itself – and you need to be able to prove it to potential customers and partners. If not, they'll understandably be hesitant to rely on your services and trust you with their data.

For small businesses, the Cyber Essentials certification programme is a great solution. It's accredited by the UK government and delivered by the IASME consortium (iasme.co.uk), which became the National Cyber Security Centre's (NCSC) sole Cyber Essentials Partner in April 2020.

Cyber Essentials provides a clearly defined, widely recognised security framework, which can save you from having to formulate policies and practices from scratch. The guidance is broad and, for the most part, non-prescriptive, so it can apply to a wide range of business types; rather than mandating specific tools and settings, it guides companies through assessing their exposure, identifying possible vulnerabilities and implementing whatever measures are necessary to close them off.

Cyber Essentials certification is a requirement for any organisation bidding for UK government contracts that involve handling certain types of sensitive or personal data. But even if you have no interest in that sort of project, certification demonstrates to your customers, partners, staff and suppliers that you're taking cyber security seriously. Moreover, should you fall victim to an attack or data breach, your certification will show that you understood the threats and took steps against them, potentially helping minimise your liability and the damage to your reputation.

■ What does certification mean?

Cyber Essentials certification is an indication that a company recognises its security responsibilities and has implemented at least a minimum level of protection against attacks. To gain certification a business must implement a set of basic technical controls, which protect them –

and the data they work with – from online security threats.

However, qualifying isn't like passing a driving test; it's not a one-off assessment that then remains valid for

decades. Since technology moves quickly, and new types of online threat are appearing all the time, it requires annual re-certification.

Indeed, since Cyber Essentials was introduced in 2014, the criteria for certification have been revised several times. A significant update in early 2022 broadened the scope of the programme to include guidance on cloud services, multi-factor authentication, PINs and passwords. Other changes have reflected

“Certification demonstrates to your customers, partners, staff and suppliers that you're taking cyber security seriously”

adjustments to the way day-to-day business is conducted: for example, it now takes in the security implications of remote working and BYOD policies that allow staff members to work on their own devices.

Many of the steps required for certification are simply good business practice, such as backing up data and storing those backups remotely; the guidance even explicitly spells out the need to install and enable antivirus software. As the government points out, “cyber-attacks come in many shapes and sizes, but the vast majority are very basic in nature, carried out by relatively unskilled individuals. They’re the digital equivalent of a thief trying your front door to see if it’s unlocked.”

There are five key requirements that organisations must meet in order to gain certification:

- **Use a firewall to secure your internet connection**
- **Choose the most secure settings for your devices and software**
- **Control who has access to your data and services**
- **Protect yourself from viruses and other malware**
- **Keep your devices and software up to date**

These requirements may sound obvious, but it’s worth thinking about what they mean for an organisation of your specific size and structure. Procedures that are

suitable for a sole trader working from a laptop will be very different to those appropriate for an enterprise, which may have adopted a cloud-centric workflow to enable data sharing and more efficient working across multiple sites and time zones. Controlling access to data is another area where the appropriate steps may vary enormously from one business to another.

■ How do you get certified?

There are two levels of certification: Cyber Essentials and Cyber Essentials Plus. The first simply involves auditing your own infrastructure and filling in an online survey. If your responses satisfy the criteria, you qualify for certification – but don’t assume this is a mere box-ticking exercise. An assessor will examine your answers, and you may be told you need to make changes and reapply for certification.

For organisations employing fewer than nine people, each application costs £300 plus VAT. This increases in tiers, topping out at £500 plus VAT for 250+ employee organisations. Once you’ve paid your fee, the process itself should be quite speedy: the target is for you to receive either certification or feedback within three days of submitting your survey.

You might wonder whether this basic certificate is really worthwhile, since it relies so heavily on self-

Cyber Essentials or ISO 27001?

Although Cyber Essentials certification is open to any organisation in the world, its benefits mostly apply to UK-centric businesses. By contrast, ISO 27001 is an internationally administered and recognised standard, which covers a broad range of security and accessibility points. If you’re communicating with non-UK companies and selling to an international market, then the ISO badge is likely to be better understood and appreciated.

Be warned, though: ISO 27001 certification is much harder to obtain than Cyber Essentials. It requires not only examination of your IT infrastructure and related policies, but auditing of your record keeping, documentation and wider procedures. There’s nothing stopping you pursuing both Cyber Essentials and ISO 27001 certification, but since the latter requires a bigger investment of time and effort, you may decide to skip the UK scheme and focus on pursuing ISO accreditation.

reporting. However, the process of working through the survey questions can help expose gaps in your protections, or in your awareness of what’s happening on your network. And, as pointed out above, cybercriminals like to look for easy targets; simply confirming that

“Many of the steps required for certification are simply good business practice, such as backing up data and storing those backups remotely”

you meet the standard Cyber Essentials criteria also confirms that you’ll pass a malicious actor’s “unlocked door” test, making it more likely they’ll move on to seek

more promising victims.

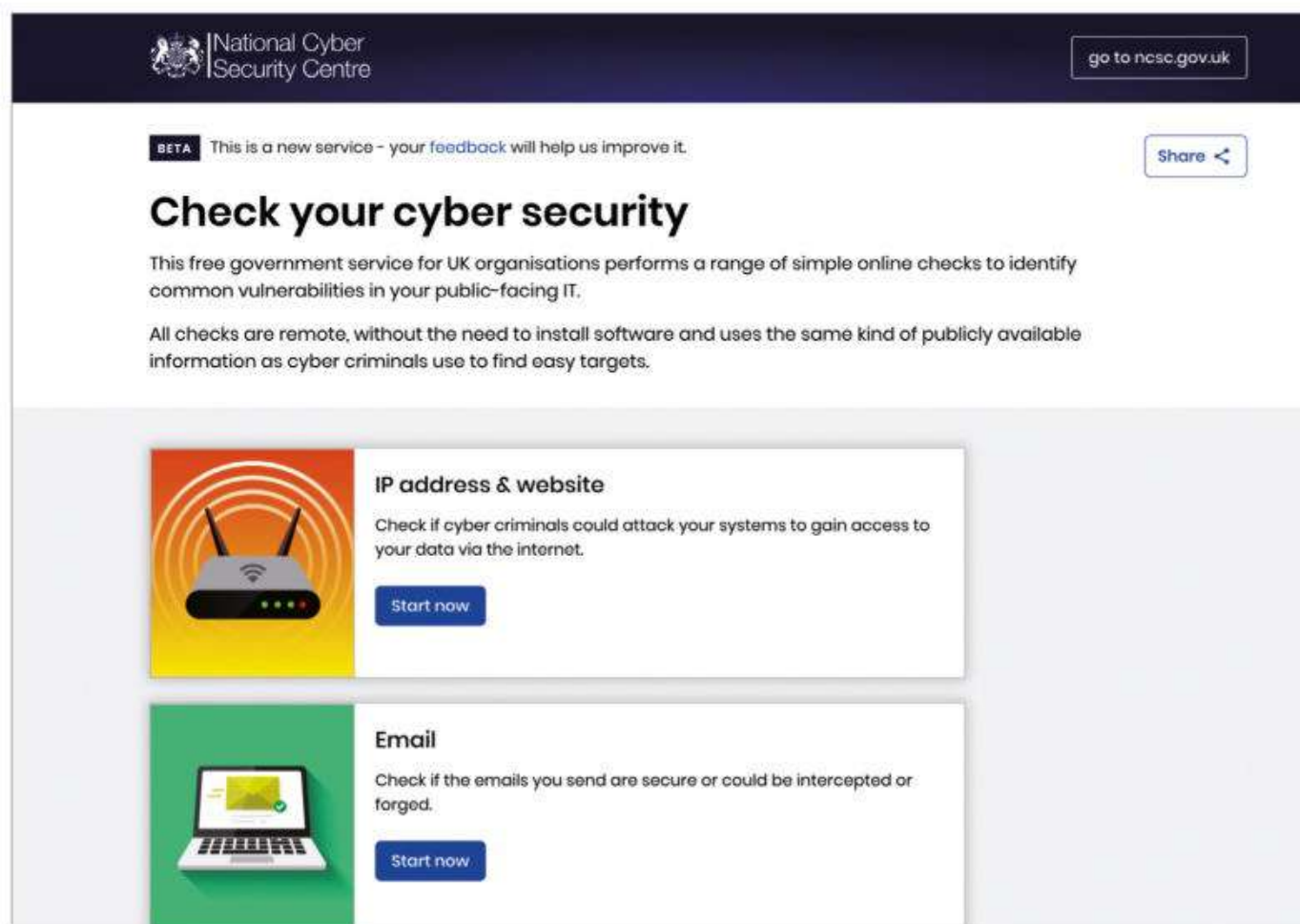
The rigorous Cyber Essentials Plus certification starts at £1,400 plus VAT. It includes more detailed guidance, with a broad toolkit organised into three sections, designed to help you prioritise appropriate investment, develop a roadmap for implementing security measures and efficiently demonstrate compliance. The idea is to embed cybersecurity within your business and its culture, help organisations to gather the information they need to understand their existing level of exposure to threat and how it can be mitigated and, finally, to implement necessary changes and plan for potential incidents. To confirm that you’ve met the required standard, an independent assessor tests your systems and judges your level of exposure.

To qualify for Cyber Essentials Plus you also need to complete the standard online Cyber Essentials assessment; if you’ve recently completed Cyber Essentials, you can upgrade to Plus by taking the additional required steps within three months of certification.

■ Testing your own systems

Whether you’re applying for Cyber Essentials or Cyber Essentials Plus – or if you’re just curious – the NCSC’s

BELOW The NCSC site can help you check your current setup



“Check your cyber security” site has a trio of online tools to help you gauge the degree to which your current setup leaves you exposed. You’ll find them at tinyurl.com/357check.

The first tool carries out a scan of your IP address and web domain, to see whether you’re hosting any exposed files or databases that an attacker could potentially access. It also checks for remote-access services that could be compromised. If anything untoward is detected, the tool will provide a brief explanation of the risk and suggest some steps for remedying it; for example, the scanner detected an FTP server running on my network, and provided instructions for shutting off external access on a variety of common routers.

The email tester inspects the domain and server you send messages from, to see whether it supports encryption and digital signature technologies. If it doesn’t, you’re at greater risk of being taken in by phishing attacks, as you can’t authenticate the origin of incoming messages. The service also checks whether someone could spoof your domain to send out spam or malicious emails that appear to come from you.

Finally, the browser test simply checks that your current web browser is up to date, to ensure that you’re not vulnerable to any exploits in earlier versions. I found the results of these tests illuminating: although I hadn’t been aware of any issues with my own systems, the tools found open ports and exposed databases on a variety of domains, misconfigured email servers, and a browser that was very slightly out of date (using the Chrome 121 engine, rather than Chrome 122).

We’d also recommend working through the Cyber Essentials readiness tool at tinyurl.com/357ready. This asks a series of questions about your organisation, your hardware and software, cloud and server resources, and policies, on the basis of which it draws up a Cyber Essentials readiness action plan. This includes a record of your answers, suggests technologies that can help and, where necessary, provides action points for plugging gaps in your defences. Even if you don’t intend to seek certification, this advice can help make your organisation more secure.

Who can get certified?

In its first ten years of operation, more than 120,000 Cyber Essentials

BELOW The Cyber Essentials criteria can be useful no matter what your business



“Even if you don’t intend to seek certification, the online advice can help make your organisation more secure”

certificates have been issued. While many of those were given to big companies, plenty have also gone to small businesses and charities. The government publishes specific cybersecurity advice for sole traders and small businesses wanting to get certified at tinyurl.com/357guidance.

Certification isn’t restricted to companies based or registered in the UK; overseas organisations can also take part in the scheme. You can search for organisations to whom a Cyber Essentials Certificate has been issued in the last 12 months at tinyurl.com/357search.

While many companies may get certified as a confidence-building measure, some will have gone through the process to qualify them to apply for UK government contracts. Note, though, that while Cyber Essentials is a necessity for many government contracts, some departments have additional requirements: the Ministry of Defence, for example, requires certification not only for direct

suppliers, but also for organisations further down the supply chain, providing products and services at a second, third or further remove.

Is it right for you?

Not all government contracts require Cyber Essentials certification, so if you’re considering the programme for that reason, talk to the relevant department before starting work as there may be exemptions in place. Bear in mind that these won’t be the same across all areas of government, so guidance from one department may not apply equally to all others.

Even if you don’t need the certificate, you can benefit from the Cyber Essentials principles. We’ve mentioned the free testing tools above, and the programme also comes with extensive publicly available documentation, which can help you harden your defences against malicious actors, or to reduce the vulnerability of your data. From a security standpoint, working through these exercises will give you exactly the same benefits as paying to be certified. At worst, you’ll gain a clearer idea of your current position and can gain guidance on how to improve – the only downside is that you won’t have the certificate to prove it. ●

Help is at hand

Small and medium-sized businesses without the expertise to work through Cyber Essentials certification themselves, or to implement its technical requirements, can get help from the Cyber Advisor scheme. This offers a directory of NCSC Assured Service Providers that can help you improve your cybersecurity processes, close off vulnerabilities and meet the Cyber Essentials criteria.

Of course, there are plenty of independent contractors who can offer similar services. But by working with a member of the scheme, businesses can be sure that any advice offered comes from a source that meets NCSC-approved standards. The individual advisor will have passed an independent assessment, which gauges their understanding of Cyber Essentials’ controls and their ability to deliver appropriate support.

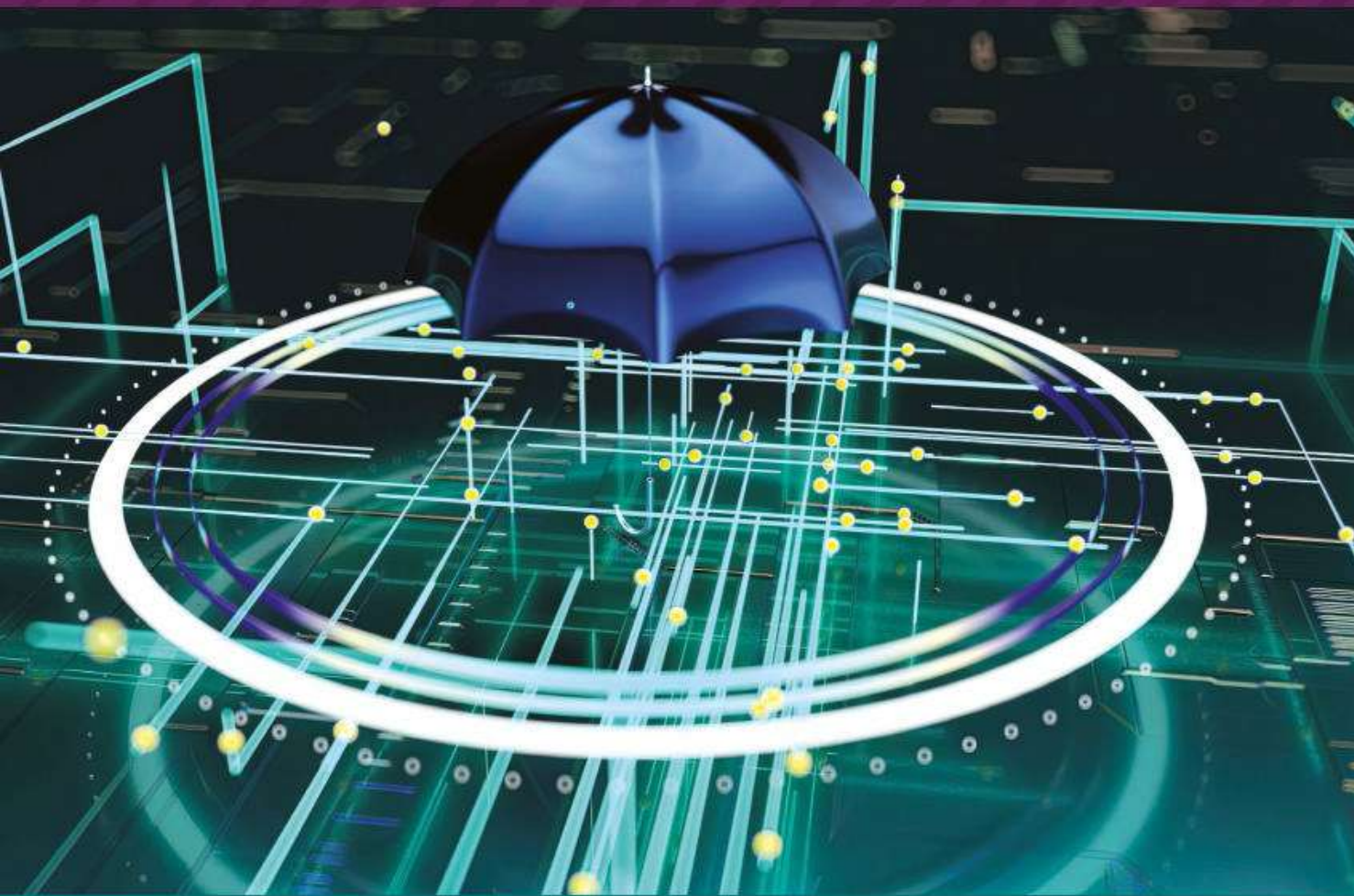
You’ll have to pay for the service: the cost will be dependent on the advisor and the size of the job. However, it’s an investment that should pay off in the longer term. Engaging an expert saves you time researching and trialling solutions, and ensures you’re not inadvertently implementing security measures that are outdated or ineffective.

Working with an accredited advisor also helps ensure that you’ll

get your Cyber Essentials certificate first time. Providers must also maintain a detailed understanding of the latest version of the NCSC Cyber Essentials Requirements for IT infrastructure, and be able to identify appropriate steps that a business can take to mitigate gaps in Cyber Essentials requirements.

To learn more, visit The Cyber Scheme (thecyberscheme.org), which is currently the only NCSC-certified assessment body offering Cyber Advisor-relevant services. And if you’re engaging with an advisor who claims to be qualified, ask to see their certificate: all certificates carry a QR code, which allows them to be validated in real-time.





AI TRiSM

New computing paradigms come with new challenges.
Steve Cassidy explores how to use AI safely and securely

I've heard of a prism... what on earth is a TRiSM?

Your uncertainty is understandable, as it's a rather forced acronym. Simply put, it refers to the particular human and organisational issues raised by AI adoption projects, namely Trust, Risk, Security and... well, the "M" just stands for Management. Which is fine, because the first three points are quite big enough to require attention and consideration on their own.

I can see why trust is an issue – ChatGPT talks a lot of nonsense.

Businesses wanting to embrace AI certainly need to think about how to deal with unreliable output – and indeed how to detect it. Old tales from the 1970s come to mind of bosses ordering employees to double-check computer calculations by hand.

But the problem runs deeper. The inner workings of AI algorithms are by design completely hidden, so underlying problems may be almost impossible to diagnose or fix.

What about risk – is that the threat of an AI taking over the world?

Hopefully that sort of thing falls outside of your corporate AI functions, but for a business the issue

could still be existential. The question here is not just how much reliance you can place on your AI, but what the consequences could be if it steers you in the wrong way. You may struggle to insure a manufacturing system that refuses to explain its recommendations.

Questions of accountability loom large, too: there's a suspicion that some AI users delegate decisions to the machine as a way of dodging their own responsibilities. Even with the purest of intentions, making the move entails a certain business risk, which again your insurers may well have opinions about.

So is this really just all about keeping insurers happy?

Not directly. Ideally, AI should reduce your computing risks, or at the very worst not increase them. Reckless businesses that play fast and loose with new technology will pay a price sooner or later, so while insurers may have their own perspectives on risks and rewards, they can serve as a broad reflection of whether or not your AI activities are supportable.

At least with the security aspect we're on familiar ground, right?

Don't speak too soon. AI security can start with extending your existing policies and procedures to cover the incoming platform. But there are new concerns, too: could someone trick the AI into doing something it shouldn't, or sharing confidential data? And if they did, how would you know about it? Since you have no visibility into the inner workings of the AI, these aren't questions with easy answers.

So how do we implement TRiSM?

The above highlights the difficulty with TRiSM: this isn't a standard toolkit you can install to help run websites faster, or identify rogue customers. It's a checklist of concerns, some human, some technical, which may require wide-ranging responses.

Don't feel too defeated, though. This is the sort of thinking that ought to accompany any business project. Jumping through hoops for insurers has been a tedious but unavoidable part of industry for many decades; all that's really new with AI TRiSM is its specific focus, and the breadth of the risk issues it entails.

And will AI TRiSM actually improve our productivity, or is it purely defensive?

The TRiSM side of things is aimed at avoiding pitfalls and liabilities, in both your technical workflows and your organisational processes. The AI itself is what's supposed to benefit the business; whether it does or not is wholly down to how you use it. ●

The unseen danger of shadow AI

Even if your business doesn't officially use AI, the technology could be putting your security at risk. That's because workers are increasingly embracing so-called "shadow AI" – turning to public platforms like ChatGPT to help with professional tasks.

While taking this initiative might be considered "working smarter", the use of unsanctioned AI services is dangerous. Like all shadow IT, it cuts responsible support staff out of the loop, giving them no visibility into security liabilities, and no way to control the flow of potentially sensitive data.

This is a particular concern with AI, as generative models have a tendency to store information that's fed to them, and regurgitate it in uncontrolled ways. Last year Samsung banned all staff from using ChatGPT after the service started sharing confidential company data gleaned from employee enquiries; Apple rapidly followed suit.

This doesn't necessarily mean you need a complete AI ban in your own business, but at the very least you must track who's using what services and get ahead of any data-security liabilities.

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Real world computing

Expert advice from our panel of professionals

JON HONEYBALL

“Nailing down which device had gone rogue was the sort of wasted morning that consumes many coffee beans”

It's better to anticipate problems than be surprised by them, which is why Jon revamped his security camera setup and signed up with Starlink

I wanted to change some of the security cameras at home. At the lab, we fitted high-end Axis cameras over a decade ago. They proved an excellent investment and are still doing sterling work every day; I see no reason to change them. This is reassuring, because new, albeit higher-spec Axis cameras are priced in the “robust” corner of the price list.

At home, at roughly the same time, I went for no-name Chinese clones at around £100 each. These were adequate for the job, and supported Ethernet connection with power over Ethernet (PoE), which I consider essential for a security camera.

These cheap cameras also support a wireless connection. I happily ignored this, right up until the point where I found their failure mode. If the camera decided to crash and reset, it would come up assuming I wanted to connect via Wi-Fi. So it created a Wi-Fi hotspot and, to make this work, it had to have its own DHCP server to hand out an IP address to a connected laptop that was trying to do the setup and configuration.

You can see where this joke is going already. It even did this if there was an Ethernet cable plugged in, and it was receiving an IP address from the network. And now for the punchline: it wired up the internal DHCP server to the Ethernet cable, too, thus creating the IP mess that is two DHCP servers on the same network.

The end result is that suddenly other client devices wouldn't connect because they were getting an IP address in the default 192.168.x.x range of the faulty camera's DHCP server, not the 10.101.x.x range of the

main network. Nailing down which device had gone rogue, and whether it was some unknown box that had been plugged into the network, was the sort of wasted morning that consumes many coffee beans.

Having been hit with two of these cameras going rogue this way, I knew it was only time before the others gave up the ghost. In the past, I'd replaced the dead items with cameras from Samsung, including the QNO-6022R. Then the cameras stopped being branded Samsung and became Wisenet. And now it seems they are Hanwha Vision. Nevertheless, the image quality was good and the price was right. I was slightly less impressed with the baubles built into the UI, such as cloud storage features, but judicious application of a large hammer to the web UI of each camera, and some appropriate IP blocking on the firewall, ensured they wouldn't spill anything to the outside world.

However, I decided it was time to remove the last three of the original cheap cameras from the network. Call it preventative maintenance. They were going to fail at some point, just like the previous two. The only question was when.

At this point, it was time to make a decision. I looked at my requirements list for the cameras. First, they had to



Jon is the MD of an IT consultancy that specialises in testing and deploying kit
[@jonhoneyball](#)

“Call it preventative maintenance. They were going to fail at some point”

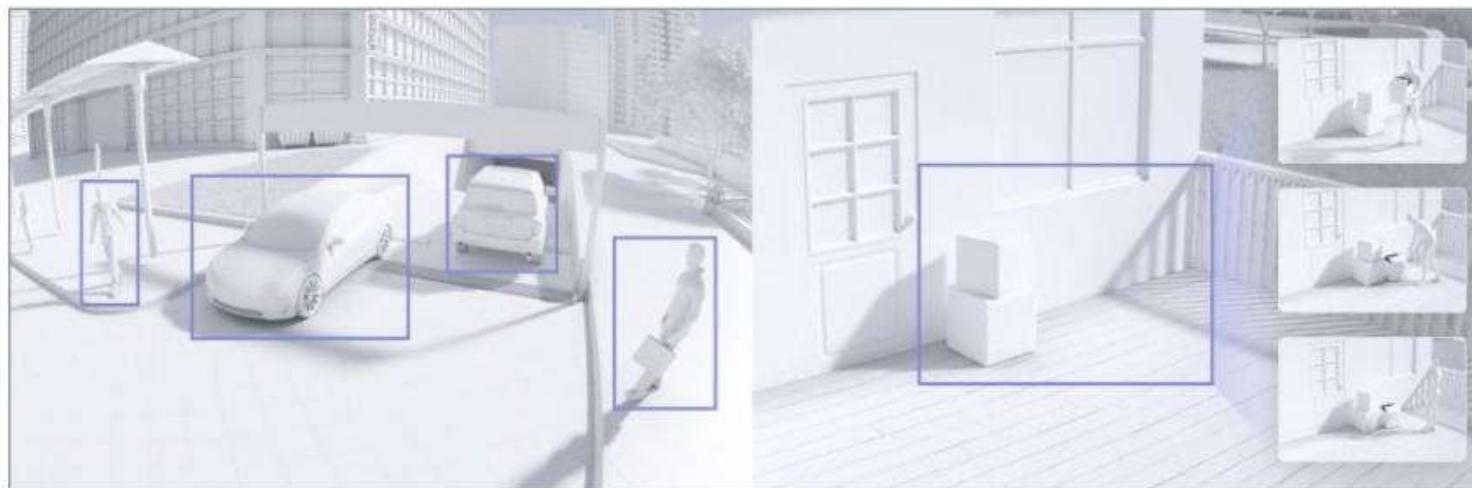
BELOW The Synology camera system can detect different types of object

be PoE and Ethernet; I will not accept Wi-Fi connected cameras. They had to work with local storage within the local network; I will not accept the primary storage being in the cloud. They had to support 24/7 recording, as I have little faith in event-driven recordings. The optical quality had to be good, and it had to have strong infrared light night-time capabilities.

Oh, and did I mention cheap? Although I don't doubt the quality and reliability of Axis cameras, the price is hard to justify for my domestic needs.

At this point, I had two main options. I am a serious user of Synology NAS boxes, having a lot of them spread across our properties. Its Surveillance Station platform is excellent quality, has been very reliable, and has good apps for iOS and Android for remote monitoring. It's free, too, which is useful. You need to pay a licence fee per camera once you've exceeded the free licence count that comes with each NAS box, but the cost is small, a few tens of pounds, and they are perpetual transferable licences.

I've been using the Synology solution both at the lab and at home now for almost a decade, and the best thing you can say is that “it just works”. If you get a more high-power NAS, then you can do deep video analytics such as face recognition,





Jon Honeyball
Opinion on Windows, Apple and everything in between – p110



Lee Grant
Tales from the front line of computer repair – p113



Olivia Whitcroft
Lawyer Olivia offers legal advice for the tech industry – p116



Davey Winder
Keeping small businesses safe since 1997 – p118



Steve Cassidy
The wider vision on cloud and infrastructure – p122

RIGHT The software even allows you to specify a “loitering” time

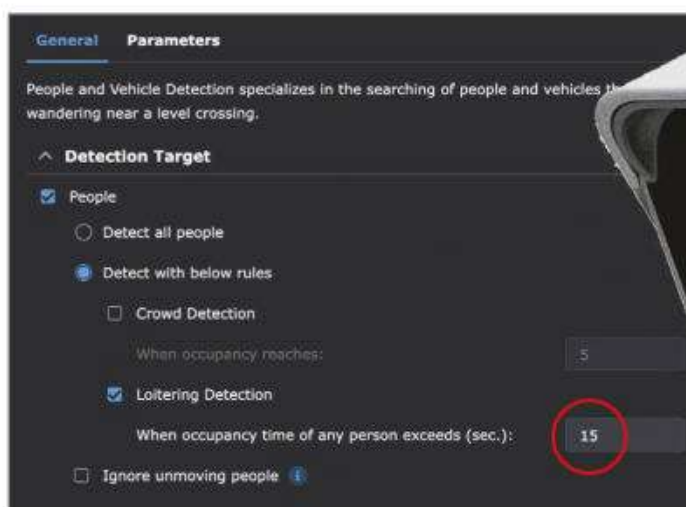
number-plate analysis and so forth. But I just need a solid, reliable solution.

The left-field option would be to use the Protect platform built into the UniFi networking system that I use. The app is great, and it ticks all the boxes for PoE, 24/7 recording and so forth. The UniFi cameras are excellent, too, with very clear optics, and the app and web UI capabilities are also strong.

If I was starting from scratch, I might be tempted to go with the UniFi solution. However, it has a couple of limitations. First, it only supports its own brand of cameras, so I would have to throw out the perfectly good Samsung/Wisenet cameras that I fitted only a few years ago. The standard UniFi firewall/gateway/fabric controllers can all take storage, but it’s single disk. I would prefer more storage and for it to be split over multiple disks. Its Network Video Recorder box would solve all of that, giving me four drive bays, but then I would need four disks. So this was simply too disruptive for my needs.

Back to Synology then. The advantage of Surveillance Station is that it supports a huge range of third-party cameras, including generic ONVIF devices (ONVIF is the open, global standard for IP security products). It also supports Synology’s own cameras, which are new to the market. Although I didn’t need them, the cameras come with a free licence built in too. The best bit would be the tight integration with the Surveillance Station platform. I’d have to accept that these cameras would be tied to the Synology platform, but since that’s my platform of choice moving forward, it seems a low-risk strategy.

Out with the credit card, and time to buy three of the Synology BC500 cameras. I engaged our electrician to go up the tall ladders, because these are mounted right up at the top of the eaves, and I’m not good with height on a ladder. It was a very quick swap over – unbolt the old camera, unplug the Ethernet cable, plug in the Ethernet cable to the new camera and fit it to the wall.



I was actually away when this was being done, but was able to happily remote in via VPN and watch the cameras, so it was easy to get exactly the angle of views that I wanted. The cameras are excellent: very crisp images, so it’s easy to read car number plates. The frame rate is high, and although I’ll always take image quality over frame rates, it’s clear you can have both with the BC500.

Getting the cameras up and running was a matter of a few mouse clicks. I dropped into the UniFi networking stack to apply fixed IP addresses to each camera based on MAC address within the DHCP server. A quick remote flick of the PoE power switch on each switch port, a reboot of the cameras, and they came up on the chosen IP address ranges. Then it was easy to configure them within the Surveillance Station platform.

I applied an appropriate bit of masking to remove the next-door neighbours’ windows from the recordings on one camera. For another, I dropped by and showed them the camera view, and asked if they were happy for it to record a small part of their back garden.

At a list price of £240 each inc VAT, this was a moderately expensive

ABOVE Synology’s BC500 camera is new and produces crisp images

“Getting the cameras up and running was a matter of a few mouse clicks”

BELOW The view from on high (installed by someone with a good head for heights)



morning. But I’m very happy with the preventative maintenance aspect, and extremely happy with the camera performance too. So it’s a win all round.

Oh, and another bonus is that the automatic object recognition works incredibly well on the new cameras. It can tell you that a car is there or if people are loitering, with Synology’s software even including an option that tells you how many seconds you consider “loitering” to be.

If I were doing a green field installation, and didn’t have local NAS storage, I would happily go with the UniFi cameras on its platform. However, a local NAS or two is very much part of my DNA, and so the choices offered by Synology – both its own cameras and its support for third parties – makes it a clear winner.

Guardians of my Galaxy

Last month I mentioned that my shiny new Samsung Galaxy S24 Ultra had died. A software update prompted by the Samsung Smart Switch application had thoroughly nuked it from orbit, and no amount of root boot mode, wiping the cache and attempting to reset to factory settings would fix the problem.

It went off to Samsung’s preferred repair place for serious surgery. A few days later, it reappeared in full working order. It had been completely wiped, which I expected, but it booted up just fine. Clearly the repair centre had more potent tools to refresh the device than are available to us mere mortals. This app is still telling me it wants to update my phone, but after this experience, I think I’ll pass on allowing that to happen.

Bitwarden 2FA

Last month I covered my annoyance at Authy pulling support for desktop



apps. It has long been my 2FA platform of choice, and this sort of abandonment makes me question my desire to continue with the company.

I looked into using the built-in 2FA tools within Bitwarden, my favourite password manager, and I've been delighted by what I've found. I needed to set up new accounts for my servers, but that's no bad thing, and hooking in new 2FA code scans for this. So far I have migrated almost all of my 2FA configurations away from Authy onto Bitwarden.

This leaves me with a quandary. My Bitwarden account is protected with 2FA, and feels a little too much like taking both feet off the ground to have the 2FA login for Bitwarden held within Bitwarden itself. I could see how that could go badly wrong, and lock me out of everything.

I could keep Authy just for the Bitwarden 2FA login, but that's messy. So I'm looking at going back to my YubiKey hardware keys and setting them up as the authenticator for Bitwarden 2FA. Of course, you never had only one YubiKey in case of failure; I have several spares and can keep one securely at the lab and one hidden away at home just in case the one on my keyring fails. Bitwarden supports up to five YubiKeys on one account, so you can protect yourself against hardware failure or loss of your keyring, and I can choose either the native YubiKey support or go for FIDO2 WebAuthn mode.

There are other hardware key tokens like this, so the choice is quite wide. But I like a quiet life,

and so will almost certainly stick to YubiKey and see how long they last.

Internet resilience is not futile

I decided I wanted to try a fully diverse internet routing solution at home. Now the usual way of handling this is to have two different feeds coming into a building; if one line goes down, the other is there to take on the load.

All of this is predicated on one simple assumption: do both lines actually take a different route to the internet from your building? You might assume this would be straightforward, but it really isn't. I remember one client in the centre of London who had two fibre lines. They came onto the site at opposite sides of the building, from two different suppliers. Everything seemed fine until both lines went down at the same time. And it transpired that Company A had subcontracted the last leg of the connection to Company B, but hadn't told the client.

So how do you go about having a resilient connection? It might seem adequate to back up a gigabit fibre connection with a straightforward 80/20 ADSL line, coming in over copper. That would be fine until someone uses a digger on the road and takes out both feeds. In a village, this is far from unlikely.

This presented me with an interesting challenge. I wanted a truly diverse route for the backup. And the obvious one was Starlink.

Over on the ever-lovely *PC Pro* podcast – sign up on our Discord server, pcpro.link/discord, and you can join in the fun every Thursday at 1pm – we refer to him as “Space Karen”. But despite what you might think of Mr Musk, it's clear that he has assembled teams of extremely

capable engineers in the various companies that he runs.

And the Starlink technology is astonishingly good. You can start with the *Thunderbirds*-style landing of two rockets boosters side by side. Or look at the low orbit constellations. But it's clear that this stuff works.

I ordered the domestic solution at £225, while the monthly “line cost” is £75, which isn't much more than a premium full-fat ADSL line.

The package came, and it was very easy to set up. I actually used the supplied foot and plonked it down in the kitchen garden. The cable was long enough to reach into my front garage, where the machine rack lives. It comes with a router that also does Wi-Fi, and I remembered to order the optional Ethernet adapter, too.

I'm not joking when I said it took less than five minutes to get everything plugged in. The aerial whizzed around and found its correct orientation, and we were up and running.

I took the Ethernet output from the Starlink router and fed it into the WAN2 port on my UniFi Dream Machine Pro (DMP) router, alongside the gigabit fibre coming in on WAN1. By default, the DMP does failover between the two lines, although I could load-share if I wanted.

And that was it. No fuss, no mucking around, it just works. I allowed the Starlink to do its initial setup of firmware updates, and then ran a test to see if there were obstructions on its line-of-sight view of the satellites. This came back with an almost perfect sky view. I will move the satellite dish to a wall mounting now I am confident of the direction and view window required, and I already have the appropriate mounting arm from Starlink.

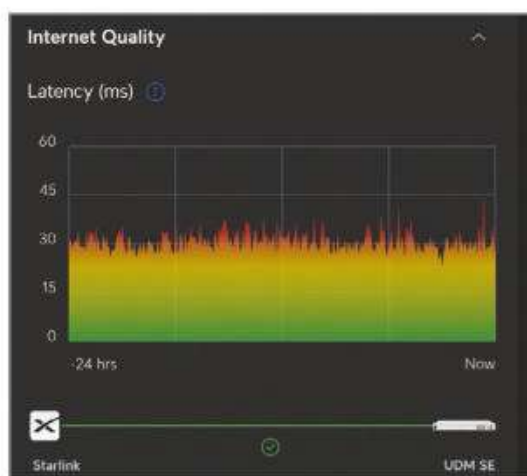
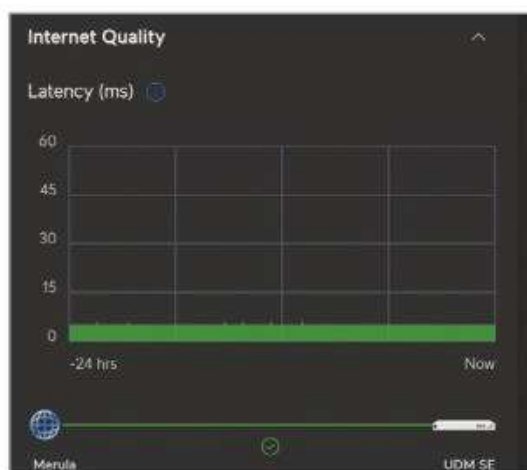
So does it work? Absolutely. A few nights ago, I had a ten-minute outage

ABOVE Bitwarden supports up to five YubiKeys on one account

“The Starlink technology is astonishingly good. No fuss, no mucking around, it just works”

BELOW The Starlight satellite dish can be placed on a stand or wall-mounted





ABOVE Starlink can't match fibre for latency, but it's a great backup choice

on the Gigaclear fibre, and the system seamlessly switched over to the Starlink connection. If I hadn't received a notification from the DMP, I simply wouldn't have known.

This is a solution well worth consideration as a backup to a primary connection, and it would almost certainly do just fine if you're in a remote rural location with a dreadful ADSL feed and little prospect of fibre. If the faster land-based solution eventually arrives, then put the Starlink to backup duties. You'll need a router that supports multiple WAN ports and appropriate configuration, but the DMP just does this out of the box.

For a business, Starlink costs £80 per month for 40GB of data, £150 per month for 1TB and £300 per month for 2TB. Not a huge amount of data, to be fair, but enough for a backup if your main line goes down. The hardware cost is higher than a normal fibre connection, but consider the cost of downtime. Obviously a 5G backup might work, too, but is that going to be fast enough, and do you have adequate 5G coverage anyway? That, I suspect, is a topic for a future column.

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LEEGRANT

"Tendrils of thermal compound hung between bent pins like cobwebs made from porridge"

While Lee is occupied by various bits of plastic, a repairability expert explains the complexities of tech recycling

The implications of Windows 10's forthcoming execution are rippling through our client list. There's genuine uncertainty about what to do with older hardware, and the questions fired at us basically boil down to: is it a waste of money upgrading something with such a short shelf life, or should we ignore Windows 11 and wait to see what Windows 12 is all about?

Giving clear guidance is challenging, but we do what we can. At the start of the year, a desktop computer was brought into the shop by its owner, who'd already decided that he needed Windows 11 in his life. He rummaged in his pocket and placed two pieces of shattered plastic on the counter.

The worst Windows 11 upgrade... in the world

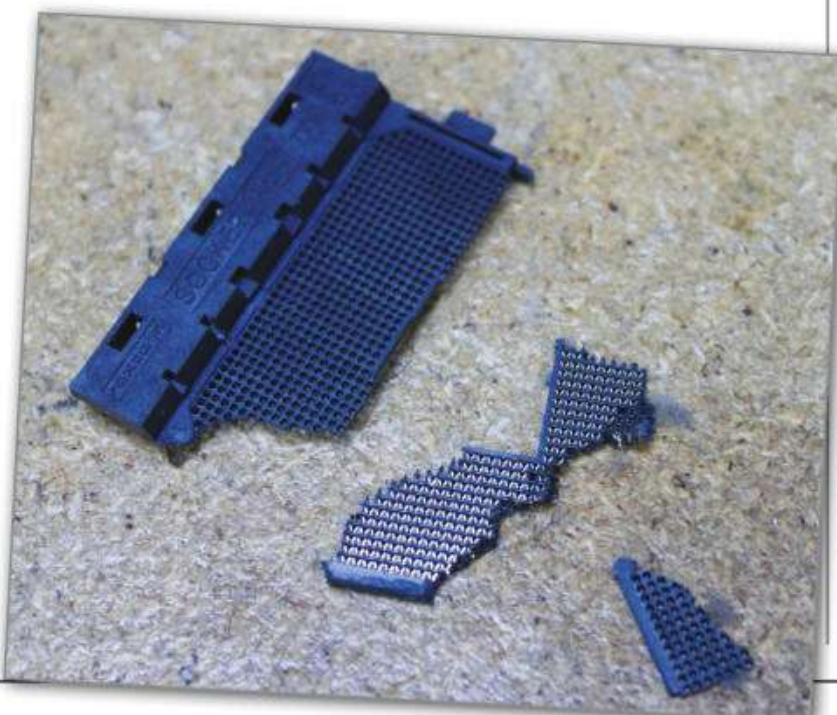
The fact that the plastic fragments were perforated told me that something serious had occurred. I unscrewed the case and peered at the expanse of exposed motherboard which was once occupied by a CPU, my eye attracted to a cluster of surface-mounted capacitors which shouldn't have been enrobed in thermal compound, but were. Seeing my perplexed expression, Harry said, "I bet you see this all the time" and, if I'm honest, I



Lee Grant and his wife have run a repair shop in West Yorkshire for over 20 years
X @userfriendlypc

"Giving clear guidance is challenging, but we do what we can"

BELOW The plastic fragments indicated that all was not well



don't think he was thrilled to be told that this wasn't the case.

Harry's AMD-based desktop was running a second-generation Ryzen that isn't Windows 11 compatible, so he'd wisely purchased a Ryzen 5 5600G upgrade. He also mentioned that the upgrade didn't fit, which is odd as both his CPUs use the AM4 socket. He passed me the new CPU, which had telltale usage and handling marks in the form of compound on the heat spreader, so I looked inside the case once again. The dimensions of the thermal-compound encrusted capacitors corresponded with a patch of wet compound leaching from between the new CPU's pins.

If you've never had the chance to play with a Ryzen 5600G, then know that the pins are on the chip and they're inserted through the perforated plastic of a PGA (Pin Grid Array) 1331 motherboard socket to make the electrical connection. 1331 equates to the number of pins sticking out of a Ryzen 5 5600G, an impressive feat of engineering for a square package only 1.57in on each side, and it's vital that no thermal compound should be used on the 1,331 pins because it will cause multiple issues.

Harry had already resolved his continuity issues by removing the non-removable PGA, leaving the capacitors that (normally) sit within the socket surrounded by 1,331 naked (and damaged) solder pads. This also gives some explanation why the perforated plastic fragments of the PGA socket were in his pocket and not on the motherboard.

It seemed that I was being presented with a distorted chicken or egg conundrum, where I needed to fathom if Madam Cluckles was thrown into the pot with an onion up her bum before or after someone had made a vanilla custard. Harry couldn't offer any certainty on the timeline of events. It wasn't imperative that I knew how his machine had been vandalised, but understanding the chronology



would reveal how far he had progressed along his Windows 11 upgrade path. I waved him off with a promise to do what I could.

Under the microscope, the new CPU looked in a bad way. Tendrils of thermal compound hung between bent pins like cobwebs made from porridge but, luckily for Harry, all the pins were present. I washed the CPU in isopropyl alcohol, scrubbing it gently behind the ears with a toothbrush as the filaments will work their way between the pins with minimum snagging.

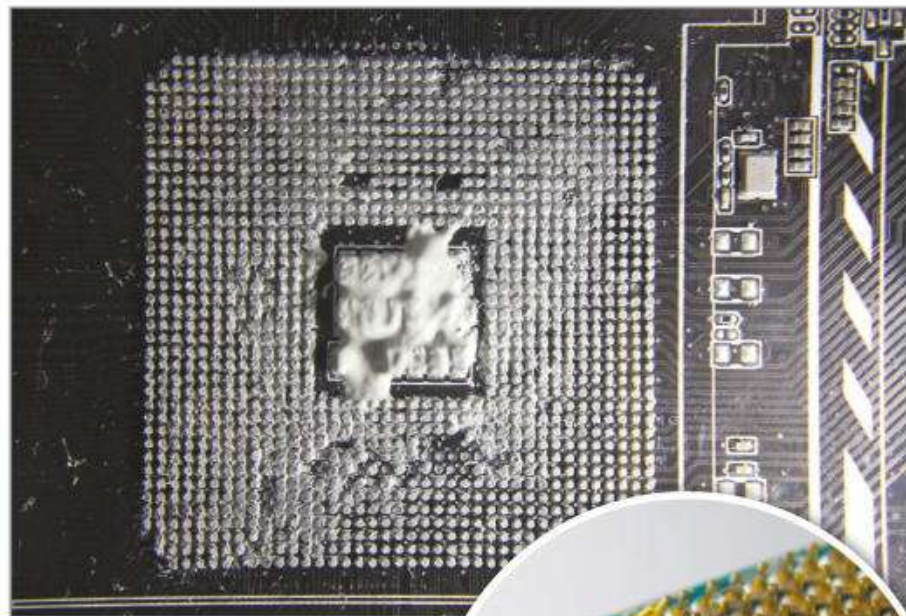
There was no doubt that the blob of compound in the centre of the CPU had been in contact with what remained in the motherboard. Perhaps Harry had injected compound into the centre of the PGA socket, then attempted to squeeze the CPU into position? During the CPU clean, I found several fragments of the broken socket, some pierced by a pin and still attached to the chip, which suggested that Harry had somehow broken the socket with the CPU in situ.

What followed were several nerve-racking hours of warming the Ryzen's pins with a heat gun to increase their malleability while using an iFixit metal spudger (tinyurl.com/357spudger) to slowly straighten and align. Many pins around the edges were flattened (suggesting the Ryzen had been dropped), and these were coaxed back with a combination of needle-nose tweezers (tinyurl.com/357tweezers), a goat sacrifice and frequent breaks to stop my hands from shaking.

Once the pins were pointing in roughly the right direction, the trick is to ensure that their 1,331 points are equidistant in all orientations, so it will drop snugly in the 1,331 perforations of the PGA socket.

I must admit to feeling a little proud that I salvaged Harry's CPU, but the same couldn't be said for the motherboard. In truth, I didn't even try. I don't have the equipment to do this without melting the PGA and, given that the replacement board was less than £50, I consigned the wrecked board to my parts bin.

Now for the (possibly predictable) twist in this tale. Once everything was bolted



together, I started the machine, which booted straight into Windows 11. Please post all theories to the usual address.

Why our stuff matters?

I'm delighted to say that one of the contributors for my recent feature about refurbished technology (see issue 334, p34) was Mark Miodownik, professor of materials and society at UCL, broadcaster and multi-award-winning author of *Stuff Matters* (tinyurl.com/357stuff). Among Mark's many areas of expertise are topics associated with reuse and reparability; earlier this year, I was fortunate enough to be present for his inaugural Albatross Lecture at Sustainable Futures in Manchester. Mark's lecture, "The End of Consumerism" (watch it on YouTube at tinyurl.com/357lecture) posits that consumerism, as an economic model, is incompatible with our climate and biodiversity goals.

During our chat, we drifted into the challenges of recycling electronics, but there wasn't room to squeeze it into the feature. As this topic stirs many *PC Pro* readers, I thought I'd include Mark's fascinating

insights as a DVD extra. We began with the basics of recycling electronics.

"If you put a device into the recycling and it ends up going to a recycling facility, we don't have the technology to turn that device back into materials that will become a new device," he said. "The problem is what you do with that waste. We often export it to other countries and then it's going to end up in the environment or being burnt and creating air pollution and soil pollution. That's a really bad outcome because the best outcome is that it gets handled safely within good recycling systems."

Mark believes that one of the main reasons electronics recycling is woefully low tech is simply a matter of money. "You might say, well, let's put money into recycling, but that technology doesn't exist yet economically. It's not being driven because you can't compete with the big mining operations and the big supply chains to get that material out of a device and back into that system."

Currently, it's financially cheaper to mine for certain raw materials than it is to invest in systems that can extract them from our waste technology for reuse. While this may mean lower-priced tech, the environmental damage of electronic product creation (known as the Upstream impact) is completely unsustainable.

"Every element is sort-of mined from several places in the world," Mark told me. "Each blasting away tons of material. Sometimes it's 100 tons to get one ton out, often using water and energy and diesel to ship it across the world."

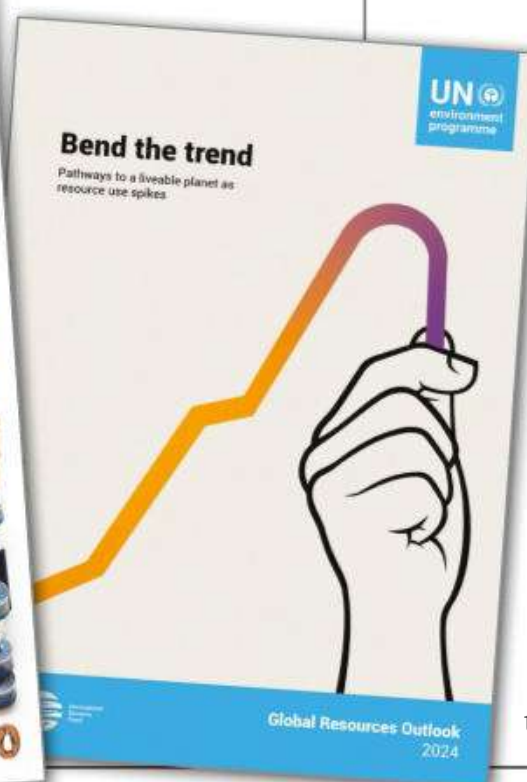
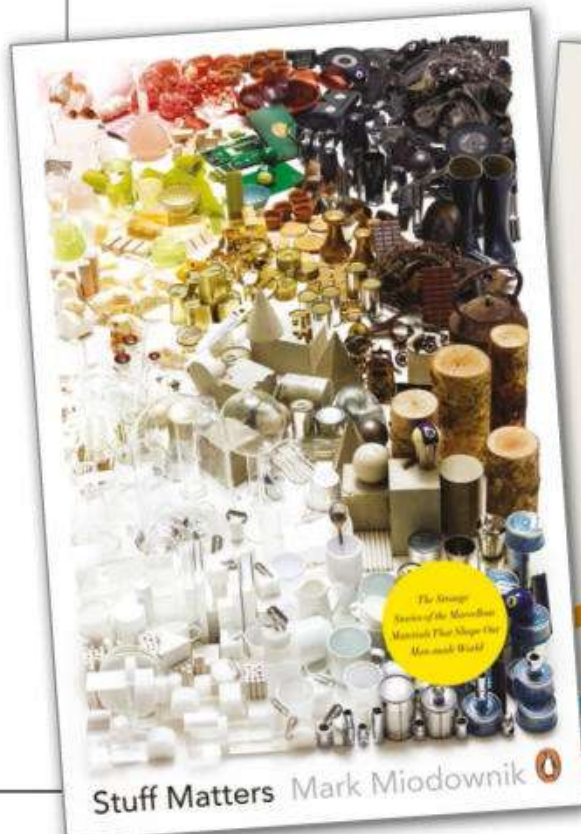
Predictably, the latest UN's 2024 Global Resources Outlook report (tinyurl.com/357report) headlines that "increasing resource use is the main driver of the triple planetary crisis" and "material use has increased more than three times over the last 50 years. It continues to grow by an average of more than 2.3 per cent per year."

The UN's report highlights that much of our problem (and if you live on this rock floating in space,

ABOVE Straightening bent pins on a CPU requires patience and steady hands

"Consumerism, as an economic model, is incompatible with our climate goals"

BELOW Mark Miodownik's *Stuff Matters* is a rollicking good read



you're included within "our") is that there's too much focus on supply-side production, rather than demand-side consumption. In other words, we have too much stuff that we don't need.

The UN's recommendation to tackle this may sound eerily familiar if you've read my previous columns: "Resource efficiency could be achieved by circular economy strategies, which include eco-design, repair, reuse, remanufacturing, refurbishment and recycling. Such strategies maintain the value of products and materials for longer, thereby reducing the need for virgin material extraction and the disposal of waste."

Although I can't disagree with this statement, Miodownik explained the fundamental economic (and technical) brick wall that makes the at-scale recycling of electronics a nightmare, especially the much-needed function to reclaim rare-earth elements. "There are two problems to solve. You have to get elements out, but you have to get all the other little bits out and they all have different chemical properties requiring different techniques to extract them. That's a big series of chemical operations, which cost energy, time and money. The other thing is we make technology by the million, in billion-dollar clean room facilities. We do chemical vapour deposition in a high vacuum environment of a particular element; indium, let's say, exactly ten atoms thick. Then another chip comes, you do the same, another chip comes and you do it 24/7. It's mass production of a very fine amount of element."

When you think of production in those terms, it becomes obvious why reversing the process, at scale, is a monumental challenge. "We have to get all things lined up," Mark said. "Imagine getting all the laptops of a particular manufacturer, extract the chips, line them up and do the reverse process. So that's a logistical problem because devices are scattered throughout the world. Also, you can't just mash them all up and extract materials from the soup because, at the moment, it's not possible. The technical challenges are immense, and they have to be driven by economic incentive because at every point in the development of that technology, you have to be able to make money."

How you can help?

Although *PC Pro* is about bringing you everything there is to know about the latest tech trends, it also promotes the need for us to consider what we

purchase and doesn't shy away from championing refurbished products. Currently, buying "not new" is one of the best way consumers and businesses dent the e-waste mountain, and Mark has a message for *PC Pro* readers about refurbished tech.

"It's going to be the norm, just like the car industry. I mean, who buys a new car? Fools and rich people. I think phones, laptops and tech will be the same. You'll get much better value, which is much more sustainable, and you won't notice it. Who says to you, 'I like your new car, was it second-hand?' No-one says that."

Overlay the UN's report of the increase in mining for over-production with Miodownik's belief that it could be 20 years before it's scientifically possible to add electronics into any form of a circular economy and you're left with the farcical notion that we're wrecking the planet to make things we don't need, that we don't use and that we can't recycle.

Congratulations humanity, slow hand claps all round!

So, for the sake of everyone, before we make purchases, we should always ask: do I really need to buy something new? Could changing the software meet my expectations? Have I squeezed everything I can out of my current hardware? Unless we change our "always new" defaults, then the prescient words of Kurt Vonnegut become an increasingly likely probability: "We'll go down in history as the first society that wouldn't save itself because it wasn't cost-effective."



ABOVE What a waste: it's too expensive to recycle electronics

"We're wrecking the planet to make things we don't need and we can't recycle"

BELOW An ingenious Lego solution to a familiar GPU problem



Block graphics

Finally, a fabulous bit of improvised engineering brilliance arrived in the shop last month. This PC was being put together as a father and son bonding project, but after a commendable build process, they couldn't get Windows 11 loaded. I had a poke around and found that one of the 8GB DDR5 sticks was faulty, fresh from the packet. Once remedied, I observed that Windows would restart, but not power off.

This symptom, as a software fault, is uncommon on new builds that haven't become polluted with the app debris, so I began to poke elsewhere, finding a faulty PSU. Now, I must offer you my sincere apologies for wasting your time as all this detail is superfluous.

The reason why I'm waffling about this machine isn't to highlight its failures, however, but its successes. During the build process, Dad spotted that the extremely long GPU (an Nvidia RTX 3070) was sagging in the PCI-E socket. Heavy GPUs do this and a staggering variety of brackets (for example, you can buy a Kolink one for £9 from tinyurl.com/357kolink) are available to offer support.

In this instance, a bracket wasn't to hand, so as Dad scratched his head, son vanished from the room to reappear with four blocks of Lego and some mouldable glue. He fashioned the blocks into a tower, positioned it under the GPU and then affixed it. A smart bit of thinking using resources at hand. He'll go far, that lad.

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OLIVIA WHITCROFT

“Is it possible to own digital assets? If not, what are you getting legally when you buy a digital item?”

Copyright and ownership of digital assets is even more complicated than they are for physical assets – such as the issue of *PC Pro* in your hands

Are you reading the digital edition of *PC Pro* or are you holding a shiny magazine? If you’ve bought the paper version, it’s yours to keep – you own it. Perhaps you’re sitting with a friend, each reading your own copies. Maybe you’ll give your copy to another friend when you’ve finished reading it.

But if you and your friend are reading a digital version, do you each “own” it? If another friend wants to read it, is it possible to hand them over your unique copy?

This leads to the bigger question of whether it’s possible to own digital assets. If not, what are you getting legally when you buy a digital item?

Property rights

Things to which personal property rights (such as ownership) can relate have traditionally been split into two categories: “things in possession” and “things in action”. The former are tangible objects that you can possess and move around. Things in action are those which are “denied physical enjoyment” and exist due to the legal system. An example is a debt; the property rights in the debt rely on legal action that can be taken against the person who owes the money.

Digital assets do not fit neatly into either category. In July 2022, the Law Commission consulted on this issue, and the final report (following the consultation) was published in June 2023. The report concludes that the law should expressly recognise a third category of personal property: one that encompasses “digital objects”, which are not tangible, but exist independently of the legal system. At the time of writing, a Bill has been proposed to address this.

But there is another condition of being a digital object: the thing must



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X @ObepOlivia

“You can own the copyright in a digital file, but you do not own the digital file itself”

BELOW Digital versions of products are legally distinct from physical ones

be rivalrous. This means that use or consumption of the thing by one person inhibits its use or consumption by another person. In other words, a digital object cannot be held or used by more than one person (or group of people) at a time. Physical objects, such as your paper copy of *PC Pro*, are rivalrous (though not digital, of course). But your digital copy of *PC Pro* is a collection of pure information, and lots of subscribers have exactly the same information. It is therefore not rivalrous and not a data object.

An example of a digital object is a crypto-token. As well as being data, it exists within a specific set of rules and infrastructure, meaning that the same discrete crypto-token can only be held and used by one person at a time.

The Law Commission’s paper also distinguishes digital objects from intellectual property, which I discuss below. The thing to which property rights attach is the intellectual property right itself (which depends on the legal system), rather than the underlying work which it protects. So, for example, someone can own the copyright in a digital file, but they do not own the digital file itself.

What are you getting, then?

I was recently advising a company selling downloadable ebooks on the terms of its sales contracts. In a contract of sale for a traditional book,

the buyer takes possession of the book, and ownership (also known as title) is transferred from the seller to the buyer. When my client sells an ebook, the buyer receives a file containing the data for that book. Some software (which understands the file format, which I’ll touch on below) will process the data and turn it into something a human can read.

As discussed above, the buyer will not own that data file. So the contract would not transfer title to the buyer. But the seller is doing two things: supplying the data file to the buyer, and allowing the buyer to download a creative work in which copyright subsists. To prepare the terms of the contract, we therefore need to consider rules relating to the supply of digital content, and the laws of intellectual property.

Supply of digital content

Historically, sales transactions were split into two categories: goods and services. If I purchase a physical book, or (with apologies for being so old-fashioned) some software or an audiobook on CD, there’s a sale of goods (under which property rights in that book or CD pass to me). If I ask a business to write some software or a story for me, it’s performing a service. The Sale of Goods Act 1979 and Supply of Goods and Services Act 1982 implied terms into this contract of sale or supply, with the aim of ensuring, for example, that goods were of satisfactory quality, and that services were supplied with reasonable care and skill.

When software started to be offered as a download rather than sold on physical media, it was unclear whether something intangible could fall within the meaning of “goods” under the legislation. Sales of downloads were often treated as supplies of services, meaning that purchasers would miss out on protections of implied terms relevant to goods.

In 2015, this uncertainty was resolved, at least for sales to consumers. The Consumer Rights Act 2015 (CRA) provides that terms relating to goods apply only to tangible, movable objects. But a third category of transaction was introduced: supplies of digital content, intended to cover products such as software apps, films, games, music and ebooks. Terms relating to quality, purpose and description are now implied into contracts for the supply of digital content,



akin to sales of goods contracts. Consumers have a clear remedy if a digital product is faulty or doesn't match what they were sold.

There is still some uncertainty for sales of digital products to businesses. However, a purchaser can seek to negotiate the inclusion of similar terms to those under the CRA. And, just to muddy the waters, software *may* be treated as "goods" for other purposes, such as under commercial agents regulations (where a company sells goods as an agent of another organisation).

Digital content is also addressed in relation to the right to cancel, under the Consumer Contracts (Information, Cancellation and Additional Charges) Regulations 2013. Consumers have a right to cancel any distance contract (such as purchasing digital content online) within 14 days of entering into the contract. But the right to cancel will end if the consumer consents to begin the supply of digital content before then, acknowledging that the right will be lost.

My ebook client therefore needed to take into account the implied terms and the right to cancel within its contracts and sales processes.

Additional rules on digital content will apply under the Digital Markets, Competition and Consumers Bill (currently going through Parliament). These include additional rights for consumers in relation to cancelling or ending subscriptions. Not that you'd ever want to end your subscription to *PC Pro*, of course.

Intellectual property

Much digital content attracts intellectual property (IP) protection. A key IP right is copyright, which subsists in relation to original literary, artistic, musical or dramatic works, films and sound recordings.

So there is copyright, which can be owned, in your digital edition of *PC Pro*. Is Future Publishing assigning ownership of copyright to you in your digital copy? I hope not, as that would be silly! The copyright holder has exclusive rights, including the right to make more copies and communicate the work to the public. If Future Publishing assigned copyright to you, it couldn't sell a copy to other subscribers without infringing your rights. What it may do, however (as with my ebook client), is grant you a licence of copyright, allowing you to access and download a copy for you to read.

There may be circumstances in which copyright is assigned, where the purchaser is intended to take

exclusive control. I advised a company creating bespoke digital videos for its customers.

Once a video was created for a customer, the company didn't intend to reuse it, nor sell the same video to anyone else. As well as supplying the video, the company could therefore assign the copyright to its customer, so the customer was free to copy and use the bespoke creative work as it wanted in future.

Another issue is whether, once you have some digital content, you can give or sell it on to someone else. This is a complex area of IP law known as "exhaustion of rights". If you've purchased a physical copy of a work in which copyright subsists, such as a book, magazine or one of those old-fashioned CDs, you're able to sell it on (in the UK) without infringing copyright. However, for something digital, due to technical differences within the legislation, there's a distinction between software and other digital content. You may be able to resell software supplied to you (as it has been "distributed" to the UK public), but the supply of other digital content is treated as a "communication" rather than distribution, and the exhaustion rules don't apply. You should therefore check the terms of the copyright licence before giving or selling a copy of digital content to anyone else.

What if there is no copyright?

There may be digital content you purchase that no copyright subsists in. This could be because copyright has expired; for a literary work in the



ABOVE Downloads were legally a grey area until the 2015 Consumer Rights Act

"Consumers have a clear remedy if a digital product is faulty"

BELOW You can resell physical copies of products without infringing copyright

UK, copyright expires 70 years after death of the author. Or it could be something that doesn't attract copyright, either because there's insufficient originality, or it isn't something capable of protection under the legislation.

I was advising a business in relation to a licence of a file format, which was needed for software to process data files using that format. It's a contentious issue as to whether a file format can be protected by copyright. Case law has established that it would not attract copyright as a computer program, but it may still attract copyright as a literary work (if it's sufficiently original). There are also exceptions to copyright infringement relevant to certain uses of file formats, including in relation to interoperability and studying functionality.

So the question was, if the file format didn't attract copyright protection (or the proposed use was not an infringement of any such copyright), what would a licensee be getting under a licence? Well, they would still be getting access to the information itself, and the confidentiality of information may be protected by contract. Confidential information could also qualify as a trade secret, for which there is statutory protection against unlawful

acquisition, use or disclosure. So the licence of a confidential file format could potentially include a right to use this information, with a contractual obligation to maintain confidentiality.

Money well spent

I hope you enjoy reading the rest of this edition of *PC Pro*. Whether paper or digital, I'm sure you'll agree it has been money well spent accessing all the authors' highly creative and original works.

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DAVEY WINDER

“If you don’t want to be part of such a data-driven ecosystem, there are alternatives out there”

Google isn’t just here for the nice things in life; it’s here to block the nasty things, too, from real-time phishing scams to the ongoing curse of spam

Kicking Google while it’s up has become something of a spectator sport these days. However, while there’s a lot to dislike about the data collection that underpins the business whose slogan used to be “Don’t Be Evil”, it’s a user choice at the end of the day. If you don’t want to be part of such an advertising and data-driven ecosystem, in exchange for the utility it undoubtedly offers, then use any of the myriad alternatives out there.

For instance, DuckDuckGo is a pretty decent and privacy-focused search engine these days. You’re spoilt for choice when it comes to browsers, with Safari on macOS being a good choice for Apple aficionados and Firefox or Brave for Windows.

Email clients are trickier when it comes to the sheer functionality and universality of Gmail, but tricky does not equate to impossible. Apple Mail can be used to read your Gmail like any other client, although I’m not a fan of the interface. Although not free beyond the basic capability version, Proton Mail is the client I recommend these days when asked for a Google alternative. Indeed, with the arrival of Proton Mail for the desktop on macOS, I’m in the process of switching to what you might reasonably call a Proton privacy



Davey is a journalist and consultant specialising in privacy and security issues
X @happygeek

“Research by Google suggests that malicious sites only exist for ten minutes on average”

BELOW Proton Mail is a great alternative to Gmail

ecosystem on my M3 MacBook Pro, and will write about how that goes in the coming months.

But for now, back to the “Google isn’t all bad” storyline. Let’s start with recent improvements to the way Google protects Chrome users through its safe browsing feature, which has recently been overhauled to provide stronger security without, Google says, impacting user privacy.

Safe browsing on Chrome goes real-time

Google says the new security protections in place for Chrome users are not only much more efficient, increasing phishing attack detection and blocking by 25%, but that they also have little impact on user privacy during the process.

In-house research by Google suggests that malicious sites – those created by threat actors to execute phishing scams, steal data and so on – only exist for ten minutes on average. Yep, ten minutes before they vanish into the ether from whence they came.

Ten minutes may not sound like a long time, but it’s plenty long enough for the criminals operating them to entrap enough users and steal the information needed to be profitable. More importantly, from the preventative perspective of the

defender, it’s too short a time to detect and block them from user browsers when safe browsing and other browser-based protections typically update the dangerous sites list only every 30 to 60 minutes.

To address this imbalance, Google announced (tinyurl.com/357chrome) that it’s introducing real-time URL protection to Chrome for safe browsing in standard mode. If you already employ safe browsing’s enhanced

protection mode then you’ll already be used to real-time checks, along with other enhancements.

Previously, the standard safe browsing mode operated by referencing the sites you visited against a local store of malicious, or potentially malicious, URLs. Being locally stored meant that privacy and performance could be maintained, but at the cost of timeliness which, as we’ve already established, is something of a big deal.

Google says the new functionality will be speedier – you can’t get much quicker than operating in real-time, I guess – but without sacrificing privacy. There will inevitably be a performance hit when you consider that the real-time protection requires checks to be made against a list that is no longer local but maintained on the safe browsing server. Google admits as much, saying that it will require “some additional horsepower from the browser”, but adds that the end user shouldn’t notice much difference as it has “worked to make sure your experience remains smooth and speedy”.

Of more interest to me, and I highly suspect you also, is how this impacts upon your privacy. Google insists that by implementing “encryption and other privacy-enhancing techniques” neither it, nor anyone else, will know what websites you are visiting. So, how will this work in practice? Get ready for the science bit.

Google has introduced a new API that doesn’t actually share the URLs of any site you visit. Hold on, isn’t sharing URLs kind of at the heart of such protections? “This is the URL I’m visiting. Check it against your list of bad URLs, will you?” Well, it would be if the list being checked contained URLs, which it doesn’t.

Any URL that isn’t already known to the server-side database will require real-time checking, and this is done by obfuscating the actual URL by converting it to a 32-byte hash, which is then truncated into 4-byte hash prefixes. Next, the hash prefixes are encrypted and sent to an Oblivious HTTP (OHTTP) privacy server.

A what now? I must admit that OHTTP was a new one for me, which isn’t surprising as RFC 9458 is dated January 2024. This proposed standard describes it thus: “Oblivious HTTP allows a client to make multiple requests to an origin server without that server being able to link those requests to the client or to identify the requests as having come from the same client, while placing only



limited trust in the nodes used to forward the messages.”

Google’s check-hashed 4-byte prefixes have any potential user identifiers removed before being forwarded, via a secure TLS connection that mixes requests from multiple Chrome users, to the safe browsing server itself. It’s here that they’re decrypted and matched against the “known” database. Any matches prompt a warning to be shown in the Chrome browser, all in real-time as well as in private.

How private is private?

I know that there will be many readers sceptical about the veracity of the privacy claim, given this is Google making the proclamation. I was equally sceptical, so did more digging.

Google says that it has partnered with Fastly to provide and operate the OHTTP server that sits between the Chrome browser and the safe browsing server. That OHTTP server ensures that your IP address is never seen by the safe browsing server, and the mixing of requests with multiple others means there’s no correlation between your checks as you continue to browse.

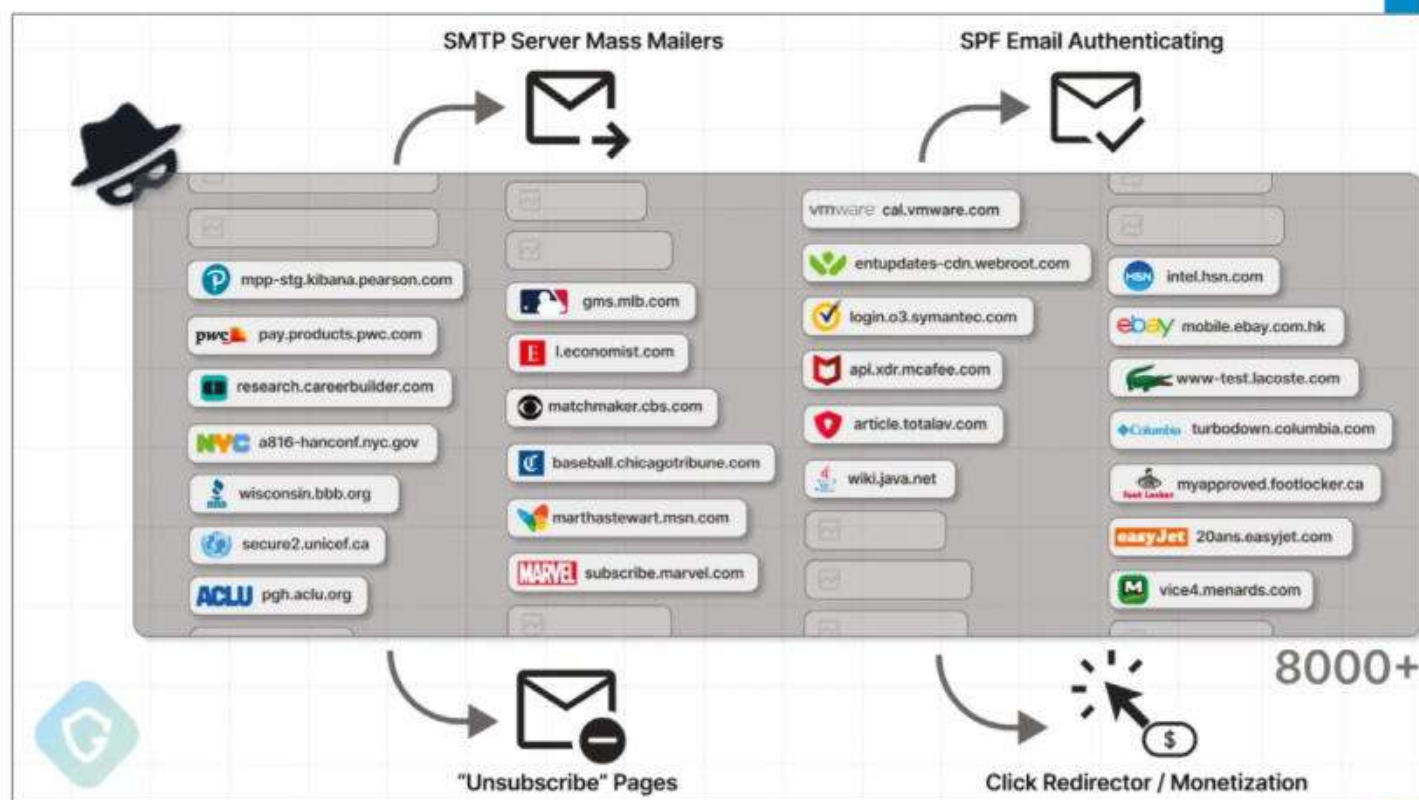
Still not convinced? How about throwing in that all hashes are encrypted using a safe browsing public key by Chrome before leaving your device? A key that the OHTTP server receiving them doesn’t know, so cannot decrypt them itself. Google describes this as offering “privacy from the privacy server itself”.

Okay, so if we can agree that the privacy protections in place appear to be pretty robust, what about the performance hit that Google has confirmed the user’s Chrome browser will take courtesy of the real-time nature of safe browsing?

To dilute the latency added by sending the server request, Chrome will first check the cache, or rather caches as it checks both the global and local to your device one. I’d better explain what each of these contain.

The local cache has saved hashes from earlier safe browsing checks your Chrome browser has performed: any unexpired cache matches result in no real-time request then being sent. The global cache contains the hashes URLs known to be safe and is fetched in the background by Chrome.

Once again, no real-time request is made for any full hashes that are matched as these are considered much less of a risk. And in case you were thinking that sending all these additional requests isn’t



going to improve latency but rather the opposite, the caches are stored in memory.

For even more protection, you might consider activating enhanced safe browsing, which adds deep file scans and leverages AI models to block attacks as well as providing protection from malicious Chrome extensions.

Less spam, fewer malicious messages for Gmail users

Back in October 2023, Google’s product manager for Gmail security and trust Neil Kumaran posted an official announcement of intention (tinyurl.com/357gmail). Gmail would, it said, require bulk senders to authenticate their emails and allow for easy unsubscribe if they wanted their messages to reach the inboxes of Gmail users.

Well, holders of personal Gmail accounts that is, as the new guidelines don’t apply to emails being sent to Google Workspace account holders. They do, however, apply to all senders of bulk email, including those using Google Workspace accounts.

Let’s clarify what a bulk sender is as far as Google is concerned: any account sending 5,000 messages to

ABOVE According to Guardio, examples of compromised domains used for “SubdoMailing”

“We’ve focused on a crucial aspect of email security: the validation that a sender is who they claim to be”

BELOW Not heard of Oblivious HTTP? Neither had I until I read Google’s blog

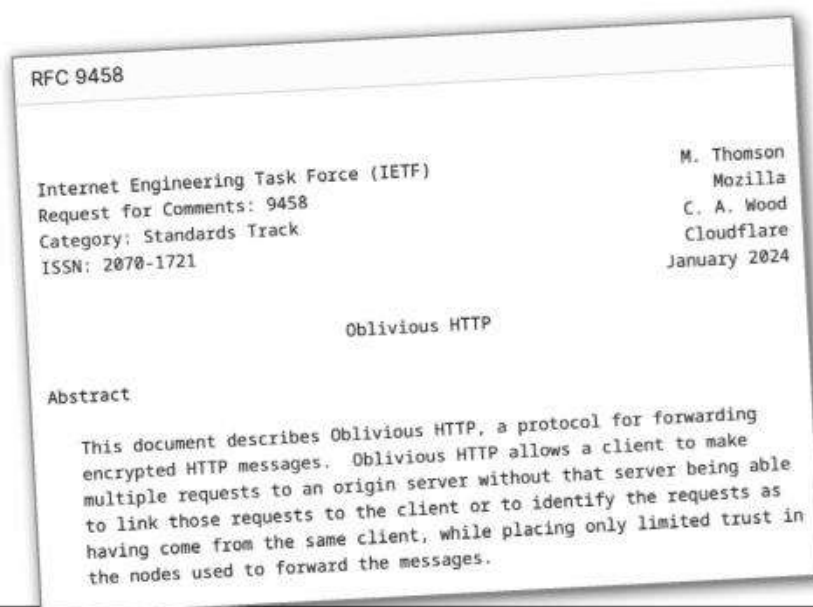
Gmail addresses in a single day, regardless of how many subdomains might have been used to dispatch them. If you hit that barrier once within a 24-hour period you are forever more labelled as a bulk sender by Google.

The new authentication regulations are the first to hit, starting in April 2024, with the unsubscribe requirement following in June.

With a mandate to boost security on the sender side of the email equation, as well as increasing the control that users have over incoming email, the new authentication regulations are quite strict and rightly so. In that October “New Gmail protections for a safer, less spammy inbox” announcement, Kumaran explained how many senders of bulk email don’t properly configure their systems, and this makes it easy for attackers to remain hidden.

“We’ve focused on a crucial aspect of email security: the validation that a sender is who they claim to be,” Kumaran said. Even though Google has required all emails sent to Gmail addresses to have some kind of authentication for a year or so now, which saw unauthenticated messages reduced by as much as 75%, that doesn’t go far enough. The mantra behind the latest Google regulations is that Gmail users shouldn’t have worry about the nitty-gritty of email security but they should be confident as to the source of the emails that end up in their inboxes.

From April 2024, bulk senders of email to Gmail addresses will need to “strongly authenticate” their emails. That means using the likes of protocols such as Domain-based Message Authentication, Reporting & Conformance (DMARC), DomainKeys Identified Mail (DKIM) and Sender Policy Framework (SPF).





Continued from previous page

Seth Blank, CTO at email domain validations platform Valimail and co-chair of the IETF DMARC Working Group, wrote a blog (tinyurl.com/357blank) stating that “if we can get to herd immunity (approximately 70% adoption of the largest senders), exact domain spoofing (the most pernicious) becomes economically uninteresting and criminals move on to other forms of phishing, spoofing, etc”.

His point is that email authentication, when done properly – and Google is certainly taking it seriously – protects everyone in the communication chain from consumers to commercial concerns. I concur; as consumers, we’re getting better protection from both spam and potentially malicious email, whereas on the commercial side, those whose brands are often exploited by spammers get more reputational protection.

Of course, no security protection is 100% secure; that’s the way of the world. Recent research by Guardio Labs (tinyurl.com/357guardio) explains how millions of malicious messages are bypassing protections already in place by way of exploiting a network of subdomains.

Known as SubdoMailing, the head of the Guardio Labs team, Nati Tan, told me that it’s part of a vast campaign that has been operating for more than two years, “prepping for Google’s plans to harden email authentication policies”.

SubdoMailing works by using as hosts domains that have long been forgotten and are available to buy. These can often link to a subdomain record that the purchaser then gets access to and can leverage, of recognisable brands so mail can be authenticated as if it were originating from those domains instead. The senders inject SPF records to authenticate their SMTP servers and host unsubscribe functions on the hijacked subdomains.

In response, a Google spokesperson told me: “Gmail has multiple layers of protections, and we’re constantly adding more to defend against this attack vector. However, this report underscores how important it is that we improve email authentication for the entire email ecosystem.”

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STEVE CASSIDY

“Real security people shake their heads at such a concept. I have two responses”

One of the lessons of the 2017 WannaCry ransomware attack on the NHS concerns DNS, and there are ways for businesses to protect themselves

Iwould really quite like to quote you a whole load of security statistics, provided by **NordLayer.com**, revealing the proportion of your workforce that’s likely to let in your next malware outbreak or ransom attack. I’d like to, but I can’t, because NordLayer’s website doesn’t want to present the report PDF on my positively Jurassic mix of hardware and browser.

Regulars may recall that I have been goofing around with a few Mac Pros, of vintages as far back as 2011. These are being re-adopted by lots of people, so it’s not impossible that they’ll crop up in small business infection/ransom situations. A couple of my Mac Pros are out with customers, running as foreign servers, not sharing login data with the rest of the network; the most likely playout of an infection event is that I, or someone very like me, will be sitting at one of those machines, aiming to resurrect the rest of the network from the backups machine by machine. The ancient nature of the Mac Pros’ OS is a main plank of its resistance to modern infection.



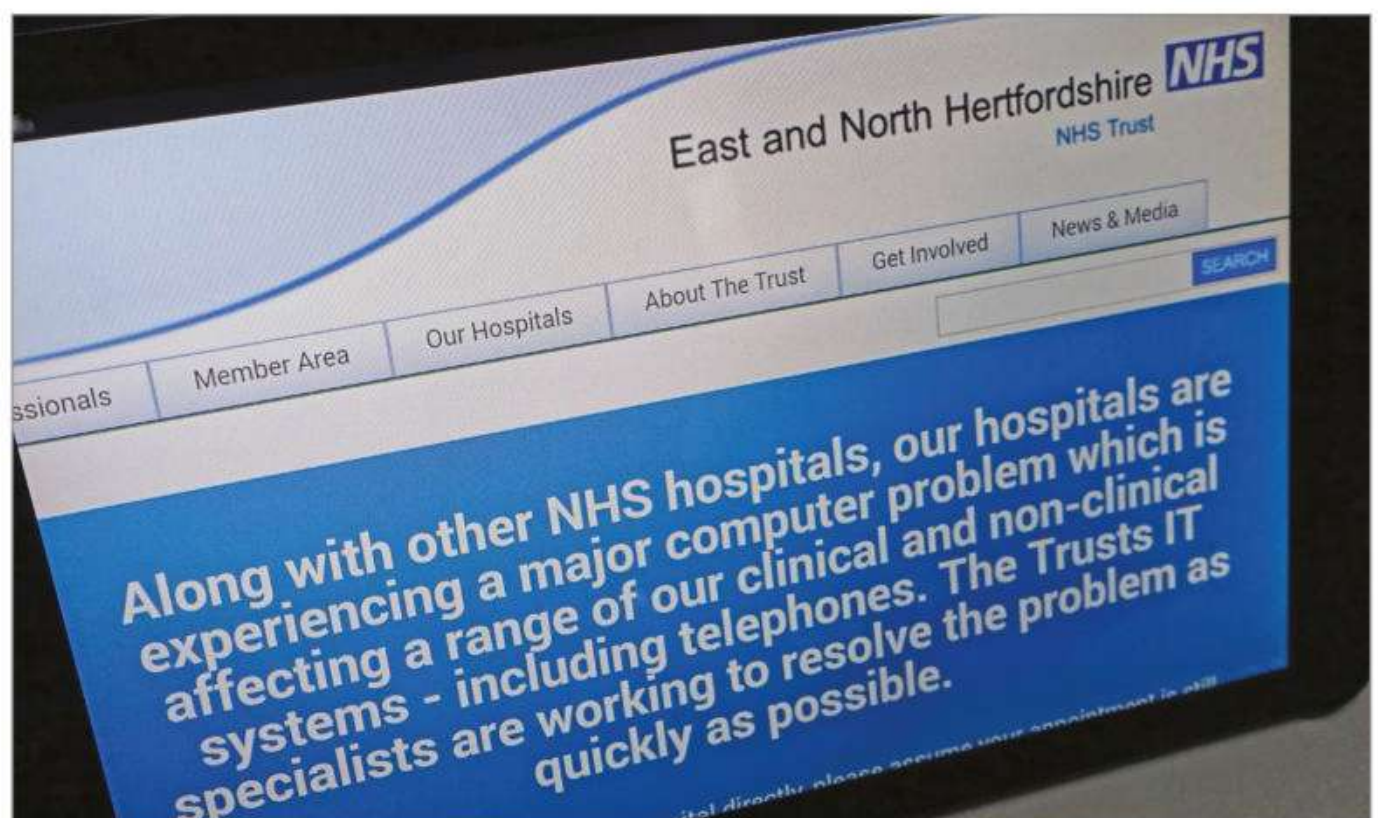
Steve is a consultant who specialises in networks, cloud, HR and upsetting the corporate apple cart
[@stardotpro](https://twitter.com/stardotpro)

BELOW The WannaCry attack in 2017 was the worst in the NHS’s history

Real security people shake their heads at such a concept. The reason I couldn’t even see the PDF I wanted was because I was on an old platform, and the experts say that nothing but the most up-to-date of machines, OS and security suite will do when it comes to the rather shady business of “fighting off the attacker”. I have two responses to this accusation.

First, let’s talk about the NHS attack. I realise that you can’t make sweeping statements about an organisation bigger than any other in the country, but I think we can look at the NHS’s worst malware outbreak and say that a decent proportion of its PCs would, on the day of the outbreak, have passed any examination for being “fully up to date”, as well as “fully installed with the latest in security”. Nobody said otherwise at the time or since.

Ironically enough, the main breakthrough in shutting the attack down had nothing to do with local software on PCs: it was a smart researcher who spotted that there was something fishy about a long and gobbledygook domain name, which appeared to



act like a global on/off switch for the infective agent.

My second response: who said I wanted to delete all infected files? The assumption is that anything infectious ought to be kept away from fallible humans and their twitchy mouse fingers. The fact is that many users can be trusted to respond logically when their antivirus alert pops up: being able to unpack an infected spreadsheet without harming it, or your machine, could give you a commercial advantage. At the very least, losing it may result in commercial disadvantage.

All of which brings me, naturally, to DNS filtering. Let's do one of those super-fast recaps that starts with "approximately 14 billion years ago..." and then brings us right up to the very latest minute. The Domain Naming System is a means of attaching text-based, hierarchically organised names to internet addresses that would otherwise be long strings of numbers.

The main reason why this global name-resolution system was used as part of the command and control of the NHS trojan is that DNS servers are both caches and propagators. Set up a DNS service inside your network and it will unobtrusively collect all the domains your users visit (that's the caching part) and, if you have a domain of your own and you were quite eccentric in setting it up, any changes to the entries therein will be copied away to public DNS machines defined as being part of the root servers group. Or just up the line to the first-hop DNS inside your ISP's data centre.

Once propagated, the entire world can use your internally generated DNS names for your servers. This is a situation you probably didn't want to enter into, and a terrible cause of confusion when it meets with the original IP and DNS service documentation. That was written long ago and at the time nobody knew whether they needed a private range for their business or whether every machine would need a globally routable public IP. The latter has not actually become any easier to decipher with the inception of IPv6.

Since "the beginning", those in charge of such things have been fixing bugs and addressing nice feature requests, but have never had a massive rethink on the way that name lookups are undertaken. Even the tiniest changes have been met with shrieks of agony by users with expectations of a globally consistent

quad9
Service
News
Support

IPv4

9.9.9.9

149.112.112.112

IPv6

2620:fe::fe

2620:fe::9

Quad9 systems are distributed worldwide in more than 200 locations in 90 nations, with extensive further expansion scheduled. Quad9 has servers located primarily at Internet Exchange points, which are where the highest concentration of interconnections occur within a typical region between networks. This results in lower latency because packets need to travel across fewer routing components, and it often leads to clients and Quad9 systems residing in the same nation, which further reduces risks to interception, interference, or observation. Quad9 also houses systems in regional datacenter locations where the combination of transit providers and proximity to large regional end-user networks makes packet delivery similarly rapid and secure.

and practically eternal service. At one point, the service was altered so that when someone mistyped a domain name they would no longer be sent to the humble 404 error page; instead, the service jumped to a search page, using the spelling mistake as the seed of the search. This sounds low-key as changes go, but the need for the DNS service to be as changeable as the Great Pyramid of Cheops became absolutely clear in the course of this and other tinier early crises.

It would be naive to think that the NHS hack was a pivotal moment in the attitude towards DNS services. DNS as a repository of data useful in malware attacks was a subject before the NHS came under attack, which is why the heroic researcher checked the peculiar domain name he'd discovered in the malware.

It took some time after this for early but still interesting solutions to break cover. I'm thinking of the big

ABOVE Visit quad9.net to see the locations of its public DNS servers

"It would be naive to think that the NHS hack was a pivotal moment"

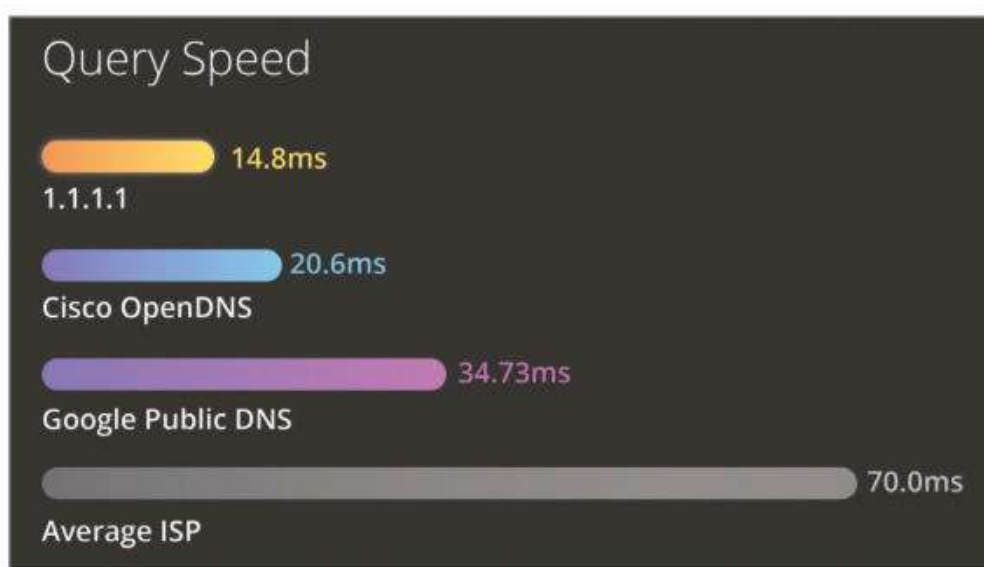
BELOW Cloudflare makes some strong claims about the speed of its service

public server replacement initiatives: products such as quad9 (quad9.net) and the Cloudflare public DNS server (found, of course, at 1.1.1.1). I've listed these two side by side because they take a similar approach: both look similar to what you get if you take an older, plainer public DNS server as your upstream relay. You throw their server a site's domain name, and it throws back some numeric addresses that your machine uses to hit the server.

If we ignore the more complicated bits of server-to-server chitchat, then that simple name-address couplet from browser window to web host is what most DNSes spend their lives doing. However, Quad9 and Cloudflare realised that the internal behaviour of the DNS code is up for grabs, because it has so few inputs or outputs. It's practically a one-trick pony during long-term operation, with lots of space and time for the DNS process to receive a name

request, find that the name is on one of the "naughty step" lists, and then return no answer at all to the requesting browser.

According to those figures in the report I couldn't read, the primary takeaway is that staff need help to stay on the brightly lit lanes of cyberspace, and it doesn't take much to discourage them from trying timewasting or





high-risk site addresses. A simple “host not found” is good enough to chop back on the business risk, without having to dot every “i” and cross every “t” in explaining to the end user the basis for their new hot betting site being unavailable. Being obliged to explain why a safe surfing measure is necessary, and what the outcome can be if IT advice is ignored on this subject, is possibly the most frustrating activity I’ve ever encountered.

The last but sizeable advantage to DNS filtering is that it concerns itself with only the name of a site. This is in contrast to an approach that seemed like the way forward only a few years ago. Back then, the market was burgeoning with proxies and logging tools and routers with built-in rule tables. The idea was that to block a category of sites you felt were outside your business requirements – gambling, for instance – then all you needed to do was build yourself a set of filters based on keywords and lumps of code found in the body of a web page, not in the site’s name in DNS.

The problem with filtering on body text is that there’s simply too much of it to cope with, even when there are computers around to help. You will note that nobody has seriously proposed an AI-powered body text scanner looking for incriminating or antisocial words: we could fill the entire island of Manhattan with 2GB microSD cards to a depth of a thousand feet and still not have enough storage to cope with analysing all that.

To find that we can just focus on the domain names instead cuts the task down so we can make use of the results within the lifetime of this universe. Which is nice.



Best mix for small business DNS service

On your own secure network, ideally every network connected device will have two DNS names. One is the name you want your machine to have (here I sit, typing on C20 and saving drafts to Spinology, that being one of my NAS devices). The other is something recondite and annoying, being the numeric address of the object, written backwards with the last part always ending in “in-addr-arpa”.

With those filled in correctly, I find that machines on my network talk to each other much faster than they do without. The main advantage is that the machines stop cycling through all their other methods of verification, and just get on with the byte-shovelling on the network.

I get into a lot of scraps about this as an approach, with people who essentially want DNS to shrivel up into a tiny little service that’s only

ABOVE Every device in your network should have a DNS name (this one is called “Spinology”)

“I get into a lot of scraps with people who want DNS to shrivel up into a tiny service”

permitted to run in a dusty corner of their internet router. They don’t see the value in the enumeration of internal machines and they don’t feel like they suffer from the delays occasioned when one machine is in zone .foo, the next is in zone .bar and the server is in foobar.local.

This is the source of much angst on small networks. We all want to be able to use custom machine names, and allow devices capable of self-registration to do that on their own. But the other uses DNS can be put to – such as blocking malware communications and tedious adverts – fight more or less directly with the hands-on, edit-the-entries kind of life preferred by network managers.

This is why I like the whole idea of relay hosts. You can have all the proper entries for all your devices on a server, which is nicely editable and controllable from your desk. What’s more, it nominates just one upstream partner server. This would normally be your router, or possibly a server within your ISP’s environment, but in my perfect world this machine is also inside your LAN.

This second server runs a custom DNS such as Pi-hole (pi-hole.net), one of a new breed of automatically updated “bad hosts” list keepers. You can hop your DNS name lookups through two or three relay hosts before it all gets a bit fraught, but for my money that internal split of services, plus one of the new-school big public servers such as Quad9 or Cloudflare, really hits the spot when it comes to small business name services.

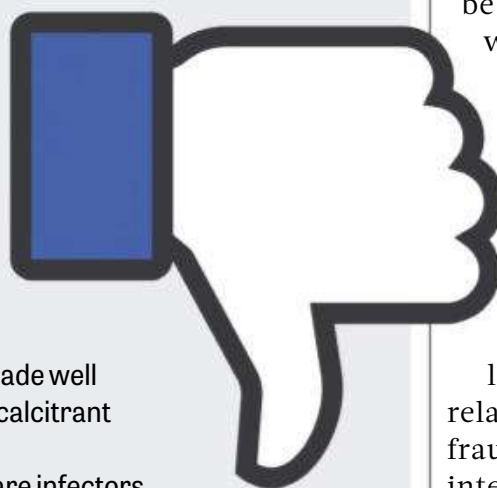
cassidy@well.com

Was it something I said?

I would have gone a lot further with the whole Mac Pro story if I had been able to contact any of the people responsible for the OS Patcher application – a crucial tool that retrofits boot-time drivers into later operating system images and folders. These people are easily found on Facebook, but I applied to join their group only to be rejected three days later. No reason given: just a flat “no”.

After that, I saw some peculiar events across my social media accounts. In particular, Facebook told me it had deleted a comment I had made well over a year back, talking about various ways to boot Windows and install recalcitrant oddities such as tablet PCs.

Facebook implied that I was trying to encourage the download of malware infectors – an idea so absurd I thought it worth mentioning here. For the next ten days or so, posts I put into private groups took several days to be published. Of course, I can’t connect this directly to the OCLP joining rejection, but if this is an example of conditioning by AI then it’s a pretty poor effort.



ABOVE I received the thumbs down from Facebook’s AI malgorithms

RETRO



Inspirational stories from computing's long-distant past

Forty years later: Osborne's real effect

It was the revolutionary company that supposedly shot itself in the foot but, as **David Crookes** explains, it also gave the technology industry a shot in the arm

As time hurtles forward, so technology advances. It doesn't take a genius to forecast that a better iPhone will arrive later this year or that Sony is likely to have mapped out the PlayStation 6 even before it unveiled the PlayStation 5. We all know that laptop manufacturers that bring out models today will have their eye on something better tomorrow. It's what makes the tech industry so exciting, both to observe and to work in.

But has this always been the case? There appears to be an assumption that consumers in the late 1970s and early 1980s weren't really aware that manufacturers would improve on the products they released. Take that at face value and you'd be led to believe that people were surprised when Sinclair followed the ZX80 with the ZX81 and the ZX Spectrum, or that Commodore didn't stick with the PET and went on to introduce the VIC-20 and C64.

Otherwise, what should we make of the Osborne Effect, which describes the dangers of prematurely

announcing a new product for fear of damaging sales of an existing device? It suggests that, in pre-announcing the Osborne Executive and Osborne Vixen when both were far from being in a suitable state for release, potential purchasers of the Osborne 1 computer held off. This caused sales to decline and the company to file for bankruptcy. Yet it sounds too simple a story.

In general, the announcement of a new product back then didn't tend to harm an existing one. When Commodore announced the C64 in the summer of 1982, for example, people continued to buy the lower-priced

VIC-20, which was first released in Japan in 1980 and continued to be sold until 1985. Likewise, sales of Amstrad's tape-based 64K CPC 464 didn't suddenly collapse when the disk-based 128K CPC 6128 was released. If anything, the former



ABOVE The Osborne 1 had a fold-down 69-key keyboard and a 5in screen

continued to outsell the latter.

So why would a premature declaration by Osborne Computer Corporation be any different? Could it be that the company was targeting a different market – professional rather than consumer – or that it was producing a niche machine?

■ The perfect brew

The Osborne Computer Corporation story began in 1980, shortly after

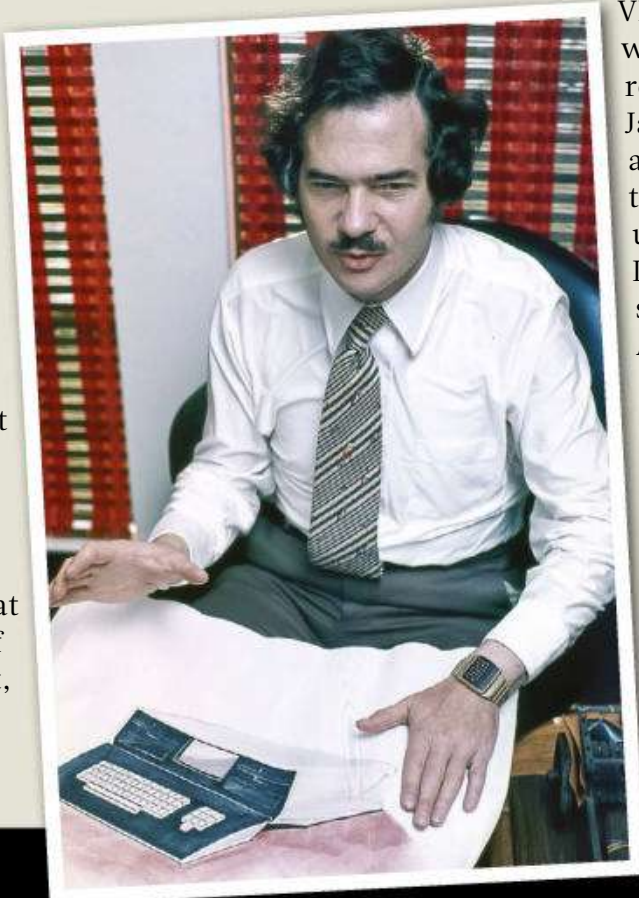
Adam Osborne, a British-American author and computer book pioneer, sold his company and strong catalogue of titles to McGraw-Hill. With a reputation for analysing and exposing the tech

industry in Silicon Valley, Osborne, who frequented the Homebrew Computer Club and wrote for the likes of *Interface Age* and *InfoWorld*, recognised a gap in the market for a portable machine.

In March that year, he was visiting the West Coast Computer Faire, where he approached Lee Felsenstein, an anti-war protestor with a degree in electrical engineering and computer science from the University of

“The Osborne Effect is the danger of prematurely announcing a new product for fear of damaging sales of an existing device”

LEFT Adam Osborne shows off the plans for the Osborne 1 computer





California, Berkeley, who had been one of the original Homebrew members some five years prior.

Felsenstein had become an influential figure who believed technology could lead to social change and open up the flow of information. He'd been integral to the launch of the Community Memory project – the first public computerised bulletin board system in 1973 – and he shared a garage with Bob Marsh, co-founder of Processor Technology. Felsenstein developed the Sol-20, the first fully assembled microcomputer based around an Intel 8080 microprocessor, which had a built-in keyboard that could be connected to a television.

Processor Technology failed in 1979, leaving Felsenstein looking for another project. “My royalty stream was cut off and I was broke,” he told *PC Pro*. “But I was walking past Adam Osborne’s stand at the West Coast Computer Faire and he said, ‘I’d like to talk to you about doing a hardware company and really doing things right’.” Osborne already knew what he wanted and he believed Felsenstein was the man to help make it happen.

“Osborne had this Gilbert and Sullivan kind of persona, the Modern Major General, I called it, and he had discovered that Americans would think you’re smarter than they are if you spoke with a British accent,” Felsenstein said. “I told him I was game for anything and we had a meeting. It turned out he was still in the earn-out period with McGraw-Hill in which he had to keep working at it. The money was burning a hole in his pocket – that’s not what he told me but that was obvious – and then he told me one day that he’d decided what we’re going to build. He sketched it out on a piece of grid paper.”

■ Osborne’s basics

The idea was to create the Osborne 1: a Z80-based computer running the operating system CP/M, which would have two 5.25in floppy disk drives, a 5in monochrome CRT display and 64K of RAM. It wasn’t a million miles away from the Xerox NoteTaker developed in the late 1970s that was never released.

“I later learned that the idea originated with a fellow named Blair Newman, who was working with Trip Hawkins,” said Felsenstein. Hawkins was the entrepreneur who had been director of strategy and marketing at Apple and went on to found Electronic Arts and The 3DO Company. “Blair had come up with some very imaginative stuff but Steve Jobs would have none of it, so the outline of the design specification floated around the industry for a



while. Adam picked it up and decided there would be a big market for that.”

Osborne had another plan. He decided consumers would be attracted to a package that not only included the hardware but key software as well. “I believe he originated the idea for selling the computer with a sufficient batch of software and he began making deals with companies including Microsoft in exchange for stock,” Felsenstein said.

The apps included CBASIC – a compiled version of the BASIC programming language written for CP/M by Gordon Eubanks – and MBASIC, which was Microsoft’s CP/M BASIC language. Sorcim was asked to develop a spreadsheet program – SuperCalc – after Osborne failed to get VisiCalc. MicroPro’s president Seymour Rubinstein agreed to allow WordStar to be bundled and invested \$20,000, leading him to become chairman of the board at Osborne Computer.

PeachTree Software’s Nominal Ledger, Purchase Ledger and Sales Ledger were also included, along with the Ashton-Tate’s database app, dBASE II. There was a grammar checker (Grammatik), a dictionary (Proofreader) and a couple of games (*Adventure* and *Deadline*).

“Acquiring software was Adam’s contribution; a brilliant contribution. He deserves full credit for it and it made the difference between Osborne’s computer and everything else,” Felsenstein added.

■ Cheap as chips

To reward and incentivise Felsenstein, Osborne offered him

25% of the company as founder stock. “There was a specified delivery date and I would lose 1% every two weeks I was late so I worked like a demon, and it was probably the last computer designed by one person,” Felsenstein said.

But he didn’t cut corners or rush the job. Osborne – aside from wanting a machine that would close up entirely, fit under an airline seat and still work if someone managed to drop it – asked for a 40-column display. “There were 40 characters per line on the Apple II,” explained Felsenstein. As it was, Felsenstein managed to up that to 52.

“I called Adam – I was under instruction to wake him up if necessary and let him know when I succeeded in getting the display,” he said. “I told him, ‘I have bad news and good news. The bad news is you can’t have 40 characters’. He started to say, ‘can you...’ and I interrupted him and said, ‘the good news is you can have 52’. He thought that was pretty good.”

Not only that, Felsenstein made the window 128 characters wide, which meant the screen could scroll. “WordStar was implemented such that it would do that automatically when the cursor got close to the side of the screen,” he added. But that’s not to say there weren’t compromises. The drives were single-sided, single-density ones capable of storing just 90K per disk. Osborne had asked for this because he was worried that double-sided drives would suffer head damage if the computer wasn’t handled carefully. The move also reduced costs.

This was important. One of the main aims was to create an affordable computer. “I had to make it as cheap as possible and as good as possible,” Felsenstein said. “My speciality at that time certainly was integrating the

video display with the personal computer processors. The standard way to do that was to go out and buy a CRT display controller chip that would organise the memory and handle the

accesses to the memory when the processor wasn’t handling it and so forth. I wanted to avoid that.”

He managed to do away with a fairly expensive chip by using part of the main memory and TTL logic to provide video and sync to the monitor. He also used bank switched memory. And while the price did rise from Osborne’s intended \$1,395 to \$1,795, that was still considered inexpensive. The software was worth about the same price and it was being

TOP The Osborne Executive is said to have caused sales of the Osborne 1 to fall

ABOVE You could detach the keyboard and also connect an external monitor to the Osborne 1

“Osborne decided consumers would be attracted to a package that not only included the hardware but key software as well”

bundled for free. The Osborne 1 was something of a bargain, despite not actually having spectacular specs.

Fast fall

Osborne the company incorporated in 1981 and had office space in Hayward, California. The computer was showcased at the West Coast Computer Faire in April that year and it certainly turned heads. *InfoWorld's* issue published on 13 April 1981 said it looked “a bit like a small sewing machine”. It also noted that “the display uses upper-case and lower-case letters, and includes underlining facilities, two screen intensities and some basic graphic capabilities”.

It was also surprised at the price. “In case you think the price printed above was a mistake, we’ll repeat it: \$1,795,” it said. And yet Osborne himself wasn’t the most natural of salesmen. “We’re producing a machine whose performance is merely adequate when compared to some of the competition,” he admitted. “It is not the fastest microcomputer, it doesn’t have huge amounts of disk storage, and it is not especially expandable.”

Such honesty feels endearingly refreshing today and it didn’t have a negative effect on sales, which topped \$1 million worth in September 1981 alone. Professionals bought into the simplicity of the machine and the fact that everything they needed was provided (other than a battery – it was a portable device but it always needed to be plugged in). And since Osborne made it clear from the outset that the computer wasn’t a world beater but a solid machine which was being offered at a great price, everyone knew where they stood. So what exactly went wrong?

In just 12 months, Osborne grew from a tiny company to one employing 3,000 people (half employees, half temps), generating \$73 million in revenue. But Felsenstein says it wasn’t very well run. “Adam had made a bet with Bill Godbout [the Silicon Valley legend who worked on the popular S-100 bus], who was one of his poker buddies, that he would be able to deliver the Osborne 1 before the end of June. We managed to get ten units out of the trunk of a car before the deadline so we had shipped but, on 1 July, they all came back because they weren’t wired properly.”

Felsenstein also recalls the first sign that had been painted for the business, which read “Osborne Computer Corporation”. “Computer had been misspelled with an ‘o’ instead of an ‘e,’” he said. And so it went on. Felsenstein says the general manager “was good at getting other people to do things – they may not have been

the right things, but he got them to do things”. The building in which they worked was concrete walls and floors. “When I was working on the final design, I had to work in the front lobby because that’s the only place you could get sunlight.”

A small room had been set aside for product assembly. “That was absurd,” Felsenstein said. “One of the things they discovered was that they needed to have the disk drives adjusted so workbenches for that started to grow from the back out into the office space. The general manager was also able to get suppliers to give us parts without purchase orders. “He told me later that if there were ever any interruption in the deliveries and so forth, the whole thing would fall apart.”

Overall effect

In light of that, Osborne’s decision to discuss the company’s forthcoming machines ahead of time was simply the icing on the cake – a misstep, but not the actual cause of the company’s collapse. Talk of other computers

actually came in 1983 when the Osborne 1 was firmly established, with the *Wall Street Journal* discussing a “lighter, more compact and less expensive machine with a bigger screen”. There was mention of an IBM-compatible portable as well.

It’s said that dealers read this and began to cancel their Osborne 1 orders, anticipating the new machines would sell better. Customers were also thought to be holding out – even as the Executive’s release date slipped. As it turned out, the Osborne Executive, also based around a Z80 processor, had a 7in screen, 124K of RAM and floppy disk drives with 160KB capacity. But it turned out to be more expensive, at \$2,495. The IBM-compatible was never released.

“The Executive was a good machine but nothing was able to save the company, mainly because it had not done the preparation it had to do to build a resilient company,” said

“In just 12 months, Osborne grew from a tiny company to one employing 3,000 people, generating \$73 million in revenue”

BELOW The advert for the original Osborne 1

BOTTOM 1984’s Osborne Vixen had a 7in display and a \$1,298 price tag

screen to compete directly against the Osborne 1. If people were holding out for anything, then it’s just as likely they wanted to see what others were coming up with, which perhaps also helps explain why the Osborne 1 had flagging sales despite price cuts.

In addressing the situation at the time (Osborne Computer Corporation had filed for bankruptcy in September 1983), Osborne said the banks’ refusal to extend credit and the high price of the Executive had a greater effect on the firm’s fortunes than any preannouncements. The growing desire for IBM-compatible machines rather than those based around CP/M was also a factor. “The Osborne Effect explanation is too simplistic,” Felsenstein said.

Osborne did make a comeback, however. Adam Osborne got a new team together, released the Vixen and went as far as to say in its adverts, “This is the computer we were going to introduce before you-know-what happened”. But it wasn’t enough and Osborne closed again in February 1986.

“My experience of the whole thing was that it was exhausting,” Felsenstein said. “I don’t spend much time thinking of what might have been, but I learned a great deal. The classic Silicon Valley phrase is ‘how hard can it be?’ And the classic Silicon Valley situation is to learn how hard it could be first hand, real-time. Failure is an option in Silicon Valley. In a way, you have to fail to succeed later because what you learn when you fail is all important, not only about the industry and its requirements but also about yourself and your limitations.”

● Lee Felsenstein has written a book about his life and career called *Me and my Big Ideas – Counterculture, Social Media, and the Future*, which is being published by Pragmatic Programmers. Visit patreon.com/lfelsenstein for updates.




The guy on the left doesn't stand a chance.

The guy on the left has two file folders, a news magazine, and a sandwich. The guy on the right has the OSBORNE 1™, a fully functional computer system in a portable package the size of a briefcase. Now in the case are the equivalent of over 1000 typed pages, stored on floppy disks.

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IBM and all today's talk about widening, 16- and 32-bit systems, we've noticed that the all-time best-selling microcomputers are still the Apple® II's. They invite you to compare. So do we.

Like Apple, the Osborne Computer Company has served certain people very, very well. So well that over 100,000 of you have bought Osborne computers.

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The essence of the Osborne concept. Yet improved in every respect. We took the best features of existing OSBORNEs and put them in a smaller case. With a bigger screen, 40-column display. And even faster response time. Result: The most powerful portable in its class. The Vixen is a fraction of the size of other OSBORNEs—yet it's packed with features lay-out computers make you wish for.

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Look what Osborne gives you now:

- Two double-sided, double-density, half-height 5 1/4" disk drives let you store up to 256 typed pages per disk.
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- 40 columns, 24 line display with easy-to-

print or read. The Vixen is a CP/M™ operating system, for access to the huge library of CP/M productivity software. All in one neat little package that is smaller than an IBM Selectric typewriter—and about half the weight. And at just \$1298. Take it away.

The Vixen is data-disk compatible with IBM PCs—and more.

Free Media Master™ software lets you exchange data effortlessly between the Vixen and over 200 other computers, including the IBM PC.

Your computing capabilities just expanded 200 times over.

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Telephone experts for answers to your computing questions. The cost shared group meetings at over 100 locations. And take advantage of thousands of public domain software packages in PCO's ever-expanding library.

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Futures

We explore the trends and technologies that are set to shape the future

13 warnings about using AI at work

AI experts from industry and academia were gathered by the Turing Institute to consider the future of the technology. Nicole Kobie reveals the lessons they offered

Odds are that you're already using AI at work, whether you know it or not – artificial intelligence powers smartphone cameras, online search and plenty of other algorithms, after all. But since OpenAI's ChatGPT landed in 2022, the generative AI explosion has changed how businesses use and plan to use this nascent technology.

It's no longer just an ingredient in a larger piece of software – though as we'll see, that's still the case – but AI is now a tool to address different problems across industries. "The question still remains on the extent to which we can really make use of this technology, and where we can actually put this technology to use safely and responsibly," said Michael Wooldridge, professor of computer science at the University of Oxford.

Is AI overhyped? Inarguably, yes. Though it's early days for generative AI, it's perhaps too soon to run mission-critical operations – but it is possible to find ways to use generative AI and large-language models (LLMs) at work. Experts from government, academia and industry gathered at the end of March for the

Alan Turing Institute's UK AI conference, revealing a host of ways in which generative AI is already being used.

That includes chatbots for M&S store staff, creating bespoke lessons for students, and generating reports from auto-transcribed meetings. All of these are small, genuinely helpful use cases: they're not upending their respective industries but enabling better work in less time.

"I think we are on the downward slope of the hype cycle, but... that's where you want to be," said Jonathan Bright, head of AI public services at the Turing Institute. "That's where people engage with the nitty-gritty of actually implementing the technology."

With careful consideration and a solid understanding of generative AI's powers and limitations, your company can do the same now while planning ahead for more substantial, mission-critical rollouts when the technology matures. Just heed these warnings from AI experts first.



ABOVE A diverse array of experts joined forces at the AI UK conference in March

1 Let others do the hard work

Are the higher-ups at your company high on the AI hype? If your boss is pushing to use AI *now*, the easiest way to make that happen without much risk is to use the AI that's being crammed into existing software. And that's happening almost across the board with Microsoft Copilot, Gemini for Google Workspace, Zoom AI Companion, and more.

"Companies are trying to embed generative AI, of which large language models are the canonical example, into everything that they can in the hope that they're going to steal a competitive march on other companies," said Wooldridge.

Why panic to put AI into production when Microsoft et al have already worked late nights to do it for you? Trial the use of virtual AI assistants, automatically generate reports and so on by enabling the AI tools being built into the software you already use. Some do come with additional charges, but your procurement team can



perhaps get a free trial, and others are free with existing subscriptions.

This lets you tick the AI box for management and find out what tools might actually be useful, all while buying time to come up with a truly transformative generative AI project. Don't fall foul of unnecessarily using AI, but ensure you have a specific problem to solve – even if the problem in question is getting an AI-hyped board off your back.

2 The doorman fallacy

Not everything needs to be automated. John Mildinhall, head of data science for retail at Marks and Spencer, points to the idea known as the doorman fallacy, in which a posh hotel decides to ditch its doorman in favour of an automatic door. After the sensors are installed and the doorman has been made redundant, the hotel realises that he had a bigger role than opening the door – he keeps out the riff raff, offers directions to incoming customers, helps people with luggage, and so much more. In Mildinhall's words: "He has a much wider function than what was written down in his job description."

At M&S, Mildinhall notes that it might be possible to let AI write product reports, but they're not useful for training new staff. "If you just automate that, while you've got a load of reports, you've got no education, no improvement, no working on the soft skills," he said. What's the point of having a library of unread, AI-written reports? Ensure that automation isn't costing your company side benefits.

3 Deluge of words

On the flip side, using AI could result in too much information to sift through. Wooldridge points to a scientific conference he was involved

in that had many more submissions than normal, as academics were using generative AI to produce different versions of their legitimate papers in the hope that one of them would catch reviewers' attention.

It's the work of moments for submitters, but those on the receiving end won't have the capacity to manage the deluge. Consider the potential flood before accepting AI content or applications.

4 Understand how they work

LLMs are probability machines. They don't "hallucinate" incorrect answers; they have no sense of what is right or wrong. Understanding those built-in limitations is key to deploying LLMs.

Mildinhall notes that they work well for practical, mundane tasks, such as cleaning data, but adds that asking for information can go terribly wrong, pointing to the many examples in which LLMs pulled in data from the open internet that was incorrect. Think about whether LLMs are the right solution for your problem.

5 Solve real, small problems

Digging out pieces of data from trusted sources, transcribing meetings to pull key points into summaries and powering natural language user interfaces for easier search – LLMs can solve plenty of small, mundane problems. And we spend a lot of time at work on such tasks that could be automated. Jonathan Bright, head of AI public services at Turing, points to doctors and social workers transcribing notes, and probation officers writing up

ABOVE Too much AI-generated content can be overwhelming

"Why panic to put AI into production when Microsoft et al have already worked late nights to do it for you?"

BELOW AI can reduce bureaucratic work for public servants such as doctors and nurses



reports. Such public sector workers can spend as much as 70% of their working time on bureaucracy, he says, adding that all of the technology to automate such tasks already exists.

Mildinhall is using the technology at Marks and Spencer to create chatbots, including one that helps retail store managers comply with rules regarding food management. It's a small but vitally important tool that saves time sifting through 100-page documents. You don't need to upend your business with AI – solving small pain points can be just as revolutionary.

6 Forget end-to-end AI

Indeed, generally, AI shouldn't do everything in a system; it's one piece of the puzzle. Ibrahim Habli, professor of safety-critical systems at the University of York, points to air travel: there's a high degree of redundancy for safety reasons. "The idea that we have AI solving all these problems is just wrong as it's just one component in a system," he said. "This fixation of end-to-end

machine learning, we need to cure... it's an answer, but not the only one."

Use the best tool for each task, even if it's not AI.

7 Be wary of vendor hype

Software vendors are riding the AI gravy train, even if the actual use of AI in their systems is limited. Beware companies using AI as a marketing tool; if you wouldn't buy their product without AI features, why would you roll it out just because they've slapped that label on it?

"The experience right now working in technology in a large organisation like ours is you are besieged by vendors who just want to sell you the latest wrapper around ChatGPT. We've also been getting it from large tech vendors as well," said M&S's Mildinhall.

He points to Office 365, saying Microsoft is building AI into every aspect of its productivity software. But that might not be what your company needs. After all, what's the point of answering an automated email with another automated email? Just because

vendors are AI obsessed doesn't mean you need to follow their lead.

8 Better work, not lost jobs

The rise of AI unquestionably threatens jobs, but it may be wiser to see the technology as a way to do work better rather than merely cheaper. Charlotte Deane, professor of structural bioinformatics at the University of Oxford, pointed to specialised tasks such as writing legal documents, a difficult job that requires training and is therefore expensive. Generative AI models are already able to manage such work if well trained, she notes.

Of course, there's more to the legal profession than churning out documents. John McDermid, programme director for assuring autonomy international programme at the University of York, notes that there's "quite a lot of evidence that skilled professionals that use LLMs do the job much better than those that don't use them". He argues that many workers will use AI as a tool to complete their tasks. "We'll end up doing those jobs in a different way."

In other words, we're not going to lose lawyers (or whatever role) – they're going to spend less time making documents and more time being better lawyers. Encourage your staff to do their work better, rather than just faster or cheaper.

9 Prompt engineering will die

Are you the person in the office known for being able to perfectly fine-tune a prompt to get ChatGPT to spit out a useful response? Sorry, but that skill won't be needed much longer. Wooldridge argues that prompt engineering may well be the only way to make these technologies behave now, but the clock is ticking.

Wooldridge says it's "bizarre and ridiculous" that we have to coach AI via "magic phrases" to get the right result. "I think that's going to be short lived. I doubt prompt engineering is going to be a professional role." Mildinhall notes that generative AI is already expanding the context window, so you don't have to remind it of your target audience every single time. Having a massive context window where the system knows your business will be the next quantum leap for AI, he predicts.

Don't focus all your time on prompt engineering – it's a useful skill now, but not for much longer.

10 Keep a human in the loop

LLMs can present information, but we need a human in the loop to ensure the data is correct, the output

is sensible, and to be responsible for decisions. Mildinhall points to satnav as an example: it's brilliant technology that enables us to drive anywhere, but we should ignore its suggestion to drive into a river. "We have similar situations all the time... we're going from making a decision to deciding if a decision was good or bad. And we need to be able to actively, explicitly articulate that change," he said.

Nigel Kingsman, head of AI assurance at Holistic AI, adds that the importance of a human in the loop depends on the use case: the higher the stakes, the more humans should be involved. And there's no technical substitute for a human. "The guardrails, you can make them robust, but they're not always going to be perfect," he said.

And regardless of the fact you didn't design the AI, you're accountable for using it, even if the developers should have spotted a fault, says Mhairi Aitken, ethics fellow at Turing. "When an organisation is deploying [AI] then that organisation is accountable for how it is used and what was wrong," she said.

In short, humans are accountable, so keep a human in the loop.

11 Keep it safe

AI must be safe. But what does that mean? Ruth Boumphrey, chief executive at Lloyd's Register Foundation, explains that safety has many angles: avoidance of actual harm; trust and whether people feel unsafe; and equity – such as who are the winners and losers when AI is used. "Things that make us safer may make others less safe," she added.

Ray Eitel-Porter, responsible AI lead at Accenture, warns that there's no financial incentive to curb the harms of AI, so independent regulators are necessary. While careful testing and strict regulation sound like they may slow down the adoption of AI, he argues that may not be the case. "We may have to wait a bit longer to get the next version of ChatGPT, but is that actually a problem if we have more confidence in the systems when they're released?" he asked.

He argues that companies will roll out AI systems more quickly if they know they're trustworthy. "That could lead to faster deployment because safety is built in from the start," he said.

For that to work, we need regulators with AI expertise, notes Aitken. Right now, regulators across



ABOVE Skilled professionals such as lawyers won't be replaced by AI

industries are having to grapple with this technology, making it harder to scrutinise claims.

Safety first, even if it slows down your deployment – *especially* if it slows down your deployment.

12 Test and test again

Just because an AI-powered system works on your laptop doesn't mean it will work across a company, says Mildinhall. "We don't release anything that has not been through multiple layers of trialling, from very

small scale through large regional trials," he said.

Part of that is to ensure that the system actually works, but also to better understand the wider implications of automating a process – and what could

happen if it doesn't work to plan. Start small, then expand – testing as you go.

13 Assess your risk

How could it all go wrong? If you don't have a worst-case scenario (and the mitigations for one) as part of your rollout plan, then you're not ready to go live. "It's really important that those [risks] are fully anticipated before this is rolled out," said Aitken, pointing to the long list of case studies where AI has gone poorly, such as with public-facing chatbots. "These are things that should have been anticipated before they were deployed," she added.

That's particularly true when these LLMs are used for a function they were not designed for or in a sector with vulnerable users or other sensitivities. If you don't know how your AI deployment could go wrong, you're about to learn the hard way. ●

"LLMs can present information, but we need a human in the loop to ensure the data is correct. Humans are accountable"

BELOW Don't follow AI blindly, just as you don't follow a satnav blindly into a river



PC PRO

Next month

ON SALE

Thursday 6 June 2024

Features



Windows 12: what we want to see

The next version is expected later this year, so we asked our editorial team what they want Microsoft to include – and rate the chances of each one happening.

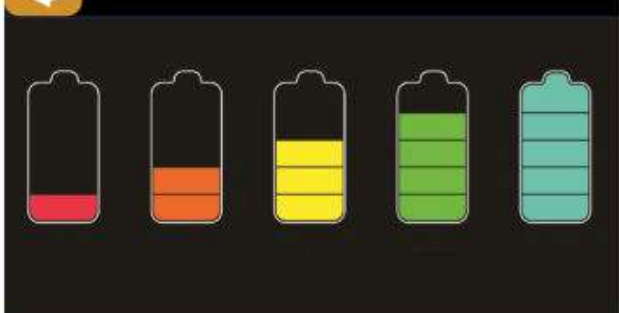
Features



How ChatGPT can change your life

AI isn't just for deepfakes and chatbots. We look at the practical ways public AI platforms can save you time and help out with everyday tasks.

Features



Leading the charge

We explore the fascinating (we promise!) technology behind charging, and find out how to make your batteries charge faster and last longer.

Labs



NAS drives

While we're fans of streaming services and cloud storage, there are still strong arguments for local NAS drives. Next month, we review the best you can buy.

Retro



Return of the Atari 400

The Atari 400 computers has been revived as a mini-console 45 years after its original release. David Crookes talks to the company that made it happen.

The Network



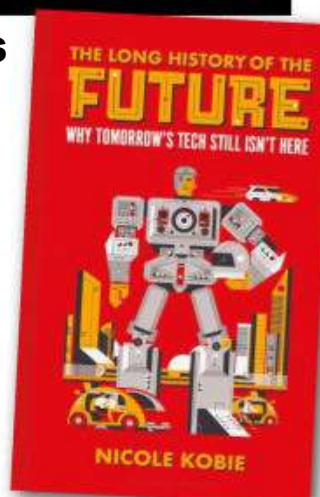
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Jon Honeyball attempts to look for the good things in computing life

Today is my 60th birthday. This fact is mostly unremarkable, and I am pleased to announce that it feels quite the same as yesterday. Nevertheless, it is always useful to mark such a day with a large gin and tonic, and ponder what the world is doing both right and wrong.

I am increasingly despondent at the state of the wider internet, specifically the spiralling mess that is social media. Clearly the big players have no interest in making things better, despite their hand-wringing and wailing to the contrary. So long as eyeballs equal cash, the algorithms will keep doing their dirty work to keep us scrolling.

X, née Twitter, still ping-pongs around on its strategy, seemingly at the whim of its mercurial owner. The latest is that the blue tick is no longer going to be paid for if you have a significant number of confirmed followers. I'm guessing the hope is that when the hoi polloi see that these higher-profile users have a blue tick it will entice them to cough up some money each month. No, I don't think that will work either.

AI continues to both astonish and concern. The things that can be done today would have seemed almost impossible only a year ago. And be in no doubt that AI is coming for jobs near you. My concern is not assuaged by AI leaders failing to deny that they have essentially trained their models on the entire public record of the internet. This is not a scenario that has a good outcome. Only the potential calamitous intersection of over-greedy investors coupled to ever-rising capital costs and energy requirements might keep that rollercoaster in check.

So among all of the angst and worry, I've looked for something more positive. And I've found it with the World Clock kit from gurgleapps.com.

This desk clock is nothing special to look at, though the design is refreshing:

it displays the current time in text to the nearest five minutes or so. The implementation is based on a Raspberry Pi Pico W and an 8x8 pixel LED matrix panel. Everything about this project is open source: you can download the code to run on the Pico W, which provides a small, embedded web server hooked up to a Wi-Fi client and server. Configuration is simple: join the local hotspot and tweak the simple settings in its web interface. Give it the SSID and password of your local network and it will stay synced to internet time servers.

It's cute, it's fun and it costs pennies to get sorted if you want to build it yourself – or you can buy the parts from the team. Or even buy a completely built unit if you want to save time.

All of this is rather lovely, but why is it worthy of your consideration? Because GurgleApps is a family firm in the truest sense, where the young children are actively involved both in the products and the YouTube channel where they discuss the projects, how to build them, and a host of useful stuff such as how to clean your soldering iron tip correctly.

It would be easy to be cynical and suggest that the parents are pulling the strings behind the scenes, but I'm sure the family is doing this together. It's a delight to see youngsters being interested in the sort of exploration that I had back as a teenager and in my twenties. When systems had to be built and configured, and you had to understand what was happening. Who else out there remembers configuring KA9Q? Or getting an early TCP/IP stack up and running?

We seem to have come full circle, and the enthusiasm of some of the younger generation for the foundations of computing brings a zip to my 60-year-old step. I'm too far

removed from current education to know what happens in schools, but if it's anything like these sort of projects then I'm fully in favour.

All of this reminded me of a *PC Pro* reader I bumped into in the lounge at Denver International airport a few years ago; he recognised my ugly mug. We got chatting over a pre-flight beer, and the discussion turned to the best programming language that his early teenage son should learn and on what platforms. I recommended obvious items like the Raspberry Pi, embedded web servers and so forth, to allow for the creation of useful but fun projects. But my main recommendation was to

“It's a delight to see youngsters being interested in the sort of exploration that I had back as a teenager. When systems had to be built and configured”

learn Wolfram Mathematica. So how lovely it was to recently receive an email from him saying his son had gone to university to read Maths, and Mathematica was his mainstay tool. And how much his son loathed and distrusted Excel.

Maybe there is a hope for a better computing future, beyond the social wasteland of X, Instagram and TikTok. Maybe buying a Word Clock kit for £35 and building it with your offspring is the best sort of encouragement?

For myself, I really should do more with the various Raspberry Pi boards I have here. And perhaps that should be the motto for my seventh decade: have more fun, build more silly things and get back to my computing roots.

■ Jon Honeyball has been contributing editor of *PC Pro* since it was founded in September 1994 – which is odd, as he still thinks he's 34 years old. Email jon@jonhoneyball.com



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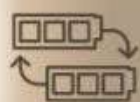
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